Tese de doutoramento

As políticas industriais de clusters como ferrementas para o desenvolvemento económico

(Cluster Industrial Policies as Tools for Economic Development: The Metallurgical Cluster & Economic Development of East Kazakhstan Region)

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Abstract

Due to the strong dependence of the economy on extraction of natural resources, in 2005, the government of Kazakhstan approved the plan to create and develop seven pilot clusters. The implementation of cluster policy mainly promoted by the government raises the question about adequateness of declared clusters, particularly the metallurgical cluster in the East Region of Kazakhstan.

This dissertation involves three parts. The first part measures the linkages among industries, in order to know what economic sectors are interconnected and to which extent. The Kazakhstan input-output table for 2009 allows the identification of industries linked by supplier-buyer relationships and to estimate the strength of their forward and backward linkages. The next step was the application of factor analysis to the input-output table in order to check the robustness of the results.

The second part assesses the innovation performance in the East Kazakhstan region in way that allows comparisons with other economies. In this part a scoreboard of indicators was built, based on the methodology of the European Cluster Observatory.

In the third and final part, some tests of the theoretical framework investigating the key factors of innovation performance are provided. Probit regression analysis is employed to estimate the determinants of innovation performance in Kazakhstan. The data used comes from the Kazakhstan – Enterprise Survey 2009, conducted by The World Bank during calendar year 2008/2009. The results are supplemented by a descriptive analysis of the data.

Finally, multi-level relationships between business organization and innovation are addresed. The literature distinguishes between two modes of learning and innovation, based on the distinction between implicit and explicit knowledge. Promotion of R&D and codification of innovation process are main features of the Science, Technology, and Innovation (STI) mode of innovation. On the other hand, the Doing, Using, and Interacting (DUI) mode of innovation is based on learning by doing. In order to take into account the specificities of the East Kazakhstan Metallurgical Cluster, a survey was conducted among a sample of firms related to such cluster. The results provide an assessment of the overall innovation performance and business environment. These results are then interpreted to offer some policy implications, and to identify areas for improvement in current practices within the cluster.

Keywords: industrial clusters, cluster identification, modes of innovation, technological innovation.

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Resumo

A República de Kazajistán exténdese nun territorio máis amplo que a totalidade da Europa Occidental, a cabalo entre Europa e Asia. A súa economía, caracterizada pola baixa densidade de poboación está baseada principalmente na extracción de recursos naturais como o petróleo e os productos metálicos.

Debido á forte dependencia da economía respecto da extracción de recursos naturais, o goberno da República do Kazajistán aprobou en 2005 o plan para crear e desenvolver sete *clusters* piloto, co obxectivo de diversificar a súa estrutura industrial elevando a competitividade das empresas non relacionadas ca actividade extractiva. O Centro de Investigación Analítica e Marketing da República do Kazajistán desenvolveu o proxecto conxuntamente cas consultoras JE Austin Associates, and Economic Competitiveness Group. O programa de creación de *clusters* tentaba elevar a capacidad innovadora das empresas promovendo activamente a creación de redes entre elas e cas universidades, institutos de investigación e administracións públicas. Durante a primeira fase do proxecto, grupos especiais estudaron arredor de cincuenta e cinco mil compañías en corenta e seis industrias abarcando as doce rexións nas que se divide o país. As restriccións financeiras e de recursos levaron ao goberno a seleccionar un número limitado de *clusters* como aquéles máis relevantes para o desenvolvemento económico da República. Un dos criteiros utilizados para a selección de sectores foi a concentración xeográfica, combinada ca existencia dunha masa crítica mínima de empresas dentro da industria considerada. Así, definíronse sete *clusters* como proxectos piloto, nos sectores do transporte, servizos loxísticos, turismo, maquinaria de extracción de petróleo e gas natural, materiais de construcción, industria alimentaria, industria téxtil e metalurxia. Algúns deles atopábanse nunha fase desenvolvida, outros necesitaban comezar dende o inicio.

A posta en práctica da política de *clusters* impulsada polo goberno prantexa cuestións referentes á idoneidade das definicións e conceptos utilizados. O traballo de investigación desenvolvido nesta tese doutoral tenta respostar a algunhas destas cuestións tomando como referencia o *cluster* metalúrxico, localizado nas rexións Central e Oriental do Kazajistán debido á concentración das actividades extractivas de minerais metálicos nesas zonas xeográficas.

A República de Kazajistán herdou da Unión Soviética un conxunto de infraestruturas de produción metalúrxica relativamente desenvolvidas e de gran tamaño. A avantaxe do país para este tipo de produción atópase na abundancia de recursos mineiros, xa que Kazajistan dispón de reservas situadas entre as tres mais amplas do mundo en metais como o zinc, tungsteno, cromo, uranio, cobre, prata ou chumbo.

En particular, esta tese concéntrase na parte do *cluster* situada na rexión Oriental, que presenta unha especialización nídia na produción de derivados do cobre, zinc e concentrado de chumbo e pode, polo tanto, considerarse separadamente do resto.

Dende a metade dos anos 90, un número elevado de rexións teñen implementado políticas industriais baseadas no concepto de *clusters* como ferramentas fundamentais para fomentar a innovación e a competitividade. A promoción e desenvolvemento de *clusters* industriais convertiuse nun tema crecemente atractivo tanto para os investigadores como para os responsabeis das políticas económicas. A popularización do concepto levada a cabo principalmente por Michael Porter (1990) dende a Harvard Business School ten convertido este enfoque nun dos eixos principais da política de desenvolvemento rexional e mellora da competitividade en moitos países do mundo. É importante resaltar, sen embargo, que a adaptación deste tipo de políticas no contexto nacional, presenta grandes diverxencias na práctica, motivadas polas diferentes condicións sociais, culturais, económicas e institucionais presentes en cada caso.

Dende a perspectiva científica, a idea do complexo industrial especializado que está na orixe do concepto moderno de "iniciativa *cluster*" ven xa de vello. A finais do século XIX, Marshall (1920) describiu a concentración de industrias especializadas nunha área xeográfica determinada nos seus *Principles of Economics* (a primeira edición data de 1890). A descripción das economías de aglomeración está presente tanto nos traballos clásicos da teoría da localización (Weber (1929)) como nos recentes avances da Nova Xeografía Económica (Krugman (1991)). En tempos recentes, Oosterhaven, Eding, & Stelder (2001), Feser, Sweeney, & Renski (2005), Sonis, Hewings, & Guo (2000), e Dridi & Hewings (2002) teñen presentado con éxito definicións do concepto de aglomeración espacial dende puntos de vista económicos, sociais e institutcionais.

Os obxectivos deste traballo de investigación están orientados dende a perspectiva dos *clusters* industriais. Un *cluster* industrial refírese a un grupo de empresas que se atopan concentradas xeográficamente e que presentan interconexións con institucións produtoras de coñecemento (universidades, institutos de investigación) e con outras institucións facilitadoras (administracións públicas, consultoras) nun campo particular, de xeito que crean novas tecnoloxías e coñecemento a través da cooperación e a interacción.

A presente tese doutoral divídese en tres partes, seguindo un enfoque gradualmente máis localizado, dende a economía nacional ata as empresas que conforman a industria metalúrxica na Rexión Oriental.

Na primeira parte da tese téntanse identificar correctamente os *clusters* existentes na Rexión Oriental da República de Kazakhstan. Para iso, mídense os encadeamentos intersectoriais dentro da economía local para así identificar cáis son os sectores interconectados e cal é á intensidade das súas interconexións. Para obter esta medición no caso da Rexión Oriental da República de Kazajistán, a investigación ten lugar en tres etapas.

Na primeira etapa discútense as metodoloxías dispoñíbeis, que inclúen a análise *input-output*, análise factorial, análise de grafos, diversos estatísticos de carácter espacial e diferentes especificacións dos cocientes de localización, así como diferentes combinacións entre eles. Como resultado desta discusión, identifícase unha tendencia na literatura a utilizar crecentemente a informacion que provén das táboas *input-output* na análise empírica de identificación de *clusters*. As táboas *input-output* permiten a identificación de industrias vencelladas por relacións proveedor-cliente, así como a estimación da intensidade dos encadeamentos intersectoriais, tanto cara adiante (orientados cara a demanda final) como cara atrás (orientados cara os factores de produción primarios).

Na segunda etapa aplícanse varias metodoloxías á información sobre a rexión do Kazajistán Oriental obtida das táboas *input-output* e se comparan os resultados obtidos con aqueles que proporciona o método descrito en Fernandez & Fernandez-Grela ((2003). Para este efecto traballase ca información obtida da táboa *input-output* nacional correspondente ao ano 2009 e elaborada pola Axencia Nacional de Estatística da República de Kazajistán. A táboa nacional rexionalízase utilizando cocientes semilogarítmicos baseados na información sobre os níveis de emprego sectoriais. Os resultos obtidos permiten acadar conclusións críticas con respecto do proceso de iniciativas *cluster* iniciado na República de Kazajistán en 2005, e sobre a capacidade deste proceso para diversificar a economía do país mediante un proceso gradual de implantación de actividades con maior capacidade de xerar valor engadido por atoparse en estadios máis avanzados da cadea de produción.

Na terceira e última etapa aplícanse métodos de análise factorial á información procedente das táboas *input-output* para verificar a credibilidade dos resultados obtidos na etapa anterior. Como resultado do proceso é posible identificar a existencia dunha concentración de empresas pertencentes á industria metalúrxica na Rexión Oriental da República de Kazajistán. No nível rexional, a especialización en actividades metalúrxicas é siñificativa. Sen embargo, no nível inter-rexional obsérvase unha elevada dispersión dos complexos industriales ao longo do territorio nacional, que redunda nunha escasa interconexión entre eles. A grande extensión do país e o mal estado das infraestructuras fai dubidar da sensatez de definir unha política de *clusters* a escala nacional. As industrias amosan interconexións moito máis fortes dende a perspectiva rexional, alomenos no que respecta á rexión do Kazajistán Oriental.

Os resultados desta medición constitúen unha base sobre a que elaborar análises máis en profundidade da infraestructura empresarial, os procesos de innovación e os posibéis atrancos tecnolóxicos e de mercado para o desenvolvemento de *clusters*. Examinar as institucións públicas e os mecanismos que poden potenciar a formación de redes interindustriais constitúe un paso valioso nesta dirección.

A innovación é un concepto que atrae cada vez máis a atención dos investigadores e os axentes que toman decisións respecto das políticas económicas. A innovación é hoxe un requisito básico para o crecemento rápido e sostible dun país ou dunha rexión. Aínda así, os estudios empíricos respecto dos resultados da innovación, que están ben establecidos no caso dos países desenvolvidos, son infrecuentes nos países menos desenvolvidos. A principal motivación desta investigación consiste en contribuir a encher este valeiro, en particular para o caso da República do Kazajistán. Unha das razóns que motivan a escaseza de traballos empíricos nos países menos desenvolvidos é a baixa calidade da información estatística dispoñible nestes países, e cómo abordar este problema é un dos eixos principais deste traballo.

Os procesos de innovación industrial son moi diferentes nos países desenvolvidos e nos países menos desenvolvidos. A maioría das innovacións radicais teñen lugar nos primeiros, pero esto non siñifica que a innovación industrial sexa menos relevante para os países menos desenvolvidos. Aínda que nestes países non se produzan innovacións orixinais no contexto mundial do coñecemento, a introdución de innovacións no contexto local das súas propias economías a partir da introdución de novos produtos e procesos é relevante para o seu crecemento económico. Os produtores asimilan e adaptan o coñecemento existente ás circunstancias do seu contexto. Para que poidan facelo, son necesarios investimentos considerabeis para desenvolver ás capacidades tecnolóxicas. Pero tamén son relevantes outros factores que están presentes tamén no desenvolvemento dos procesos innovadores nas economías desenvolvidas e que contribúen á implantación de novas tecnoloxías, produtos, procesos produtivos, institucións e estructuras organizativas.

En consecuencia, a diferencia do que acontece nos países desenvolvidos, o progreso tecnolóxico nos países menos desenvolvidos pódese considerar como esóxeno, en termos xerais. Aínda así, a adaptación técnica e a asimilación do coñecemento existente en economías máis avanzadas require que os países menos desenvolvidos poidan dotarse dunha mínima capacidade tecnolóxica (Grossman & Helpman, 1990).

A meirande parte dos estudos empíricos acerca dos resultados da innovación focalízanse en tres das economías máis desenvolvidas do mundo: os Estados Unidos, o Xapón, e Francia. Non existe, en cambio, prácticamente ningún estudio razoablemente completo que estea baseado nunha economía menos desenvolvida. Aínda así, é notorio que a evidencia acumulada a partir dos estudos realizadas ten un carácter contradictorio, do que cabe responsabilizar ás diferenzas nos períodos de tempo analizados, no alcance sectorial e na metodoloxía que presentan os estudos existentes (Kafouros M. I., 2008).

A segunda parte da tese avalía o entorno empresarial da rexión de Kazajistán Oriental en comparación con outras economías, a partir de indicadores relacionados cos resultados da innovación. Este tipo de avaliación debe implementarse dende unha perspectiva completa, que inclúa a oferta de recursos humáns, o apoio privado e público e a existencia e calidade das infraestruturas.

Para avaliar os resultados da innovación constrúese un *scoreboard* de indicadores, seguindo a metodoloxía desenvolvida polo *European Cluster Observatory*, sempre tendo en conta as especificidades do *cluster* metalúrxico da rexión de Kazajistán Oriental. O *European Innovation Scoreboard* é unha ferramenta para describir os resultados de innovación das diferentes rexións europeas. Inclúe un rango amplo de indicadores que capturan as condicións estructurais, a creación de coñecemento, a innovación por parte das empresas e os productos da innovación. Utilizando unha mostra de empresas relacionadas co cluster metalúrxico, o *scoreboard* construido seguindo as liñas anteriores proporciona unha avaliación xeral do entorno que rodea ao *cluster* e dos resultados innovadores que se obteñen dentro deste.

A metodoloxía inclúe 29 indicadores, agrupados en sete diferentes dimensións de innovación e tres grandes grupos de dimensións. O grupo de "Habilitadores" captura os principais factores determinantes da innovación que son externos á empresa e divídese en dúas dimensións: "Recursos humáns" e "Financiamento e apoio", incluíndo un total de nove indicadores.

O grupo de "Actividades da empresa" captura os esforzos innovadores das empresas recoñecendo a importancia fundamental das actividades das empresas no proceso de innovación. Este grupo inclúe tres dimensións: "Investimentos", cubrindo unha ampla gama de investimentos realizados polas empresas para xerar innovacións, "Encadeamentos e emprendemento", capturando os esforzos emprendedores e os esforzos de colaboración entre as empresas innovadoras e tamén co sector público, e "Rendimentos", incluíndo entre outros os dereitos de propiedad intelectual xerados no proceso innovador. Este grupo inclúe once indicadores en total.

O grupo de "Produtos" inclúe os resultados das actividades das empresas e divídese en dúas dimensións que conteñen nove indicadores. "Innovadores" recolle os éxitos da innovación a través do número de empresas que teñen introducido innovacións no mercado ou internamente ás súas propias organizacións, e "Efectos económicos" recolle os beneficios económicos que a innovación proporciona en termos de empregos, exportacións e vendas debidas ás actividades innovadoras (Hollanders & van Cruysen, 2008).

Os resultados amosan que a actividade innovadora na rexión de Kazajistán Oriental é similar á do conxunto do país, aínda que tanto os esforzos innovadores das empresas como os resultados das súas actividades innovadoras atópanse moi por debaixo da media europea. En relación con outros países en proceso de desenvolvemento, os indicadores sitúan á rexión na cola das economías denominadas como emerxentes. O elemento máis positivo que xurde da avaliación realizada atópase no referente á oferta de recursos humáns, onde os indicadores atópanse sorprendentemente moi perto da media europea. É importante ter en conta, sen embargo, que os indicadores dispoñíbeis aproximan únicamente a dimensión cuantitativa, e non a cualitativa, do *stock* de capital humano.

A terceira parte da tese tenta definir o proceso interno de innovación no *cluster* metalúrxico da rexión de Kazajistán Oriental. Para eso analízanse as compoñentes individuais do *cluster*, definindo os factores chave que determinan os resultados innovadores e describindo o mecanismo de creación de innovación na rexión. A selección de factores chave realízase seguindo a literatura existente, e a súa influencia contrástase mediante unha análise de regresión probit utilizando datos procedentes do *Kazakhstan Entrerprise Survey 2009* realizado polo Banco Mundial, e os resultados compleméntanse cunha análise descriptiva.

As estimacións confirman achádegos previos e contribúen con evidencia adicional á identificación da I+D e o comercio internacional como os principais determinantes dos resultados da innovación. Outros resultados adicionais apuntan a que os países menos desenvolvidos obteñen máis ganancias das importacións que das exportacións no referente á introdución de innovacións. Finalmente, a presenza estranxeira resulta ser un factor crítico para a capacidade das empresas de xerar produtos innovadores, non sendo así no caso dos procesos. É importante ter en conta, sen embargo, que a reducida dimensión da mostra dispoñible esixe manter unha certa cautela na interpretación dos resultados.

Dacordo ca literatura existente, pódense distinguir dous modos de xerar innovacións: o modo baseado na ciencia, tecnoloxía e innovacións, coñecido polo acrónimo en lingua inglesa STI (*Science, Technology, and Innovations*), e máis o modo baseado en facer, utilizar e interactuar, coñecido polo acrónimo en língua inglesa DUI (*Doing, Using, and Interacting*).

O modo STI correspóndese co tipo de coñecemento explícito e codificado que está dispoñible a través da lectura de libros, a asistencia a leccións ou ao uso de bases de datos e que difire entre individuos dacordo ca súa experiencia e formación. En troques, o modo DUI correspóndese co tipo de coñecemento implícito e tácito que é moi difícil de transferir sen interacción humana.

Para determinar cal deles é o adoptado maioritariamente polas empresas do *cluster* metalúrxico na rexión de Kazajistán Oriental, realizouse unha enquisa entre os meses de novembro 2011 e xaneiro 2012 dirixida ás empresas do *cluster*. Os resultados da enquisa foron analizados mediante a metodoloxía de análise cluster xerárquico, e achegan evidencia da existencia de avantaxes innovadoras relativas para as grandes empresas, no contexto de mercados caracterizados por competencia imperfecta. No sector metalúrxico en particular estas avantaxes poden atribuirse a necesidade de grandes investimentos en capital durante periodos prolongados de tempo baixos en un contexto caracterizado por riscos substanciais tanto de carácter tecnolóxico como xeolóxico e de mercado. O reducido tamaño da mostra dispoñible impide neste caso aplicar a análise de regresión para determinar o efecto dos modos de aprendizaxe nos resultados innovadores. Este é un tema de gran importancia para a investigación futura. En calquera caso é necesario matizar que a dubidosa calidade da información proporcionada polas empresas e, en xeral, dispoñible na rexión, obriga as máximas cautelas na interpretación dos datos, como é o caso en xeral para a investigación empírica en economías que experimentan unha situación de transición.

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Introduction

a) Cluster policy of metallurgical cluster

Since the middle of 1990, a large number of regions have implemented industrial cluster policies to increase business competence and develop competitive regional economies. Industrial cluster development has become an increasingly popular topic for researchers as well as for policy makers. Due to cluster popularization mostly by Michael Porter, the new approach became as panacea to develop regional competitiveness and to harvest economic benefits. Despite the widely promoting cluster initiatives in the world, every country has adopted cluster policy based on particular social, cultural, economic and institutional conditions.

The idea of specialized industrial complex, which is the origin of modern cluster initiative, is hardly new. In the late nineteenth century, Marshall (1920) described the concentration of specialised industries in particular area, in his book "Principles of economics". The description of industrial convergence and agglomeration economies is well presented in the works of Weber (1929) and Krugman (1991). Recently, Oosterhaven, Eding, & Stelder (2001), Feser, Sweeney, & Renski (2005), Sonis, Hewings, & Guo (2000), Dridi & Hewings (2002) have made successful attempts to define spatial agglomeration from economical, social and institutional point of view.

However, most of the empirical evidence in this field is derived from the study of developed countries. Moreover, existing studies provide sometimes contradictory evidence due to the dissimilarity of the cases they address, such as different time periods, economic institutions, industrial structures and research methodologies. There is a very limited number of studies based on developing economies. To fill this research gap and to attempt to contribute to the industrial development of the region of East Kazakhstan, hoping to be listened to, was the original motivation of this study.

Due to the strong dependence of the economy on extraction of natural resources, in 2005, the government of Kazakhstan approved the plan to create and develop seven pilot clusters. The Centre for Marketing and Analytical Research of the Republic of

Kazakhstan developed the project together with foreign consulting firms JE Austin Associates and Economic Competitiveness Group. The goal of the project was to increase the competitiveness of sectors that are not related to the extraction of natural resources. The cluster programme had been targeted to increase the innovativeness of firms through active networking among universities, research institutions, industries and government. During the first phase of the clusterization, special groups studied fifty five thousand companies, in forty-six industries in twelve regions of the country. Because of resource and financial restrictions, the government determined a limited number of clusters, which were considered the most meaningful for economic development. Seven pilot clusters were selected, including transport and logistics services, tourism, oil and gas machinery, construction materials, food and textile industries, and metallurgy. Some of them were in a more developed stage, while others needed to start from scratch.

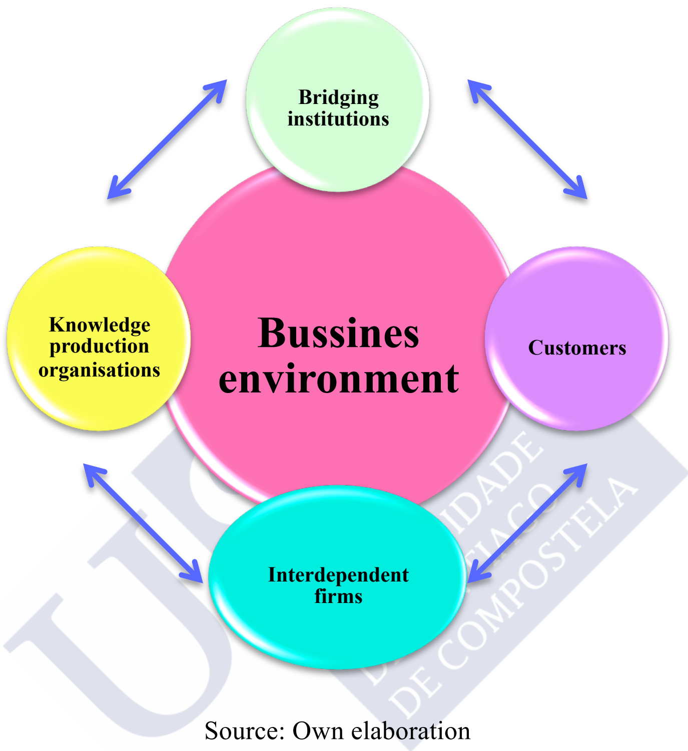
Geographical concentration was one of the criteria used in industry selection, as well as the critical mass of existing companies in the industry. The metallurgical cluster was launched basically in the Central and Eastern regions of Kazakhstan, because a significant proportion of metallurgical output is located in that area. Despite the fact that the metallurgical cluster includes complexes in the Karaganda and Eastern regions, our research is focused only on the East Kazakhstan Metallurgical Cluster (hereafter, EKMC). Both complexes have a different specialization (copper, zinc and lead concentrate are the main metallic products produced in the East Region) and different target markets, which gives us a possibility to consider these regions separately.

b) Purpose of the study and objectives

There are three main objectives in this dissertation. They follow from the definition of industrial cluster. An industrial cluster refers to a geographically concentrated group of interconnected firms, knowledge production institutions such as universities and research institutions and bridging institutions (governments and consultants) in a particular field, in order to create new technology and knowledge through cooperation and interaction (*Figure **1***).

The first objective is to measure the linkages between industries, in order to know what sectors are interconnected and to which extent. It is very important to keep the whole picture in mind, while researching a cluster in a particular area. Clusters are system phenomena, they do not exist in isolation and they spread beyond regional and national borders. These are features that have to be taken into account even if the empirical will be usually limited by the geographical specifications of statistical databases.

Figure 1: The Concept of The Cluster



Source: Own elaboration

The second objective is to elaborate a set of indicators of innovation performance in order to evaluate the business environment of the East Kazakhstan region, in a way that allows to draw comparisons with other regional and national economies. The evaluation of the business environment will be implemented from a comprehensive perspective, involving human resources supply, public and private financial support and the stock of infrastructures.

The third and last objective is to analyze the internal innovation processes within the cluster. This requires to research in a deep and precise manner the individual constituents of the metallurgical cluster, to define the key drivers of innovation performance and to describe which are the mechanisms of innovation creation in the region.

c) Research methodology

For the identification of industrial clusters in the Eastern region of the Republic of Kazakhstan, the research reported in this dissertation proceeded in three stages. The first stage consisted in the selection of one among the several methods available in the literature. These include input-output analysis, factor analysis, graph analysis, various spatial statistics, different specifications of location quotients and coefficients, and various combinations among all of them. In recent times, however, there is a considerable increase in the use of input-output tables in empirical analysis of cluster identification. The input-output table allows the identification of industries linked by supplier-buyer relationships and to estimate the strength of their forward and backward linkages. In the second stage the Kazakhstan 2009 national input-output table was regionalized through the use of semilogarithmic quotients based on employment data in order to build a regional input-output table for East Kazakhstan. Several methods of cluster identification were then compared to the one developed in Fernandez and Fernandez-Grela (2003). The results obtained allow to reach some conclusions about the adequateness of the cluster initiatives process launched in Kazakhstan in 2005 to increase competitiveness and diversify the economy of the country through gradual movement from the extracting of raw materials to high value-added production. Finally, in the third and last stage factor analysis methods were applied to the input-output table in order to check the robustness of the results obtained in the previous stage.

In order to assess innovation performance in the East Kazakhstan region, as well as to compare it with other regional and national economies, the method chosen was to build an scoreboard of indicators, following on the steps developed by the European Cluster Observatory but taking into account the specificities of the EKMC. A wide range of indicators was used, covering structural conditions, knowledge creation and innovation at the firm level, throughputs, and outputs in terms of new products and services.

Finally, in order to analyze the internal innovation processes of the EKMC, it was necessary to review the literature about key drivers of innovation performance. In order to test the adequateness of the received theoretical framework, a probit regression analysis was conducted, looking for an estimate of the determinants of innovation performance in Kazakhstan. The sources used for this analysis were firm-level data collected in the Kazakhstan Enterprise Survey 2009, conducted by The World Bank during calendar year 2008/2009. These results were supplemented by descriptive analysis. According to the literature, there are two modes of generating innovations. To research which of them is the one adopted by EKMC's firms, a survey was conducted on the region in the period going from November 2011 to January 2012. The survey was targeted to the East Kazakhstan enterprises operating in the metallurgical cluster. The process of data collection proceeded in three steps. Initially, all firms belonging to the metallurgical cluster were identified. Then, the target firms were contacted and surveyed by telephone. The last step included the re-examination of received data via Internet and published sources. The results provide an assessment of overall innovation performance and environment in the EKMC. These results are then interpreted to offer some policy implications, and to identify areas for improvement in current practices within the cluster.

d) Structure of the study

The structure of the study is presented as step-by-step narrowing of the scope of the research object, from the whole picture at the national level to the particular section constituted by the metallurgical firms in the East Kazakhstan region.

The second chapter discuss the economic overview of the Republic of Kazakhstan and the history and development of the metallurgical sector in the East Kazakhstan region. Then, the focus turns to the background of Kazakhstan's cluster policy and its implementation in the East Kazakhstan region. The empirical part of the chapter addresses the actual interindustry connections in the region and checks if the clusters identified by government resemble the nature of such connections.

The third chapter focuses on the assessment of innovation performance, based on a wide range of indicators covering structural conditions, knowledge creation, and innovation at the firm level. This range of indicators is assembled into an scoreboard, following the methodology of the European Cluster Observatory. The information summarized in this scoreboard provides an assessment of overall innovation performance and environment, that is then used to offer some policy implications, and to identify areas for improvement in current practices within the cluster.

The fourth chapter focuses on an important aspect of competitive processes, innovation performance, in the case of the EKMC. Different mechanisms of innovation creation are introduced and discussed. Finally, the main determinants of innovation performance in Kazakhstan are tested by means of a probit regression analysis.

The fifth and final chapter briefly presents the main conclusions that can be drawn from the research reported in this dissertation.

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Chapter 1. The identification of regional clusters

Abstract

The purpose of this paper is to identify industrial clusters in the Eastern region of the Republic of Kazakhstan. The research proceeds in three stages. The first stage consists in the selection of one among the several methods available in the literature. These include input-output analysis, factor analysis, graph analysis, various spatial statistics, different specifications of location quotients and coefficients, and various combinations among all of them. In recent times, however, there is a considerable increase in the use of input-output tables in empirical analysis of cluster identification. The input-output table allows the identification of industries linked by supplier-buyer relationships and to estimate the strength of their forward and backward linkages. In the second stage the Kazakhstan 2009 national input-output table is regionalized through the use of semilogarithmic quotients based on employment data in order to build a regional input-output table for East Kazakhstan. Several methods of cluster identification are then compared to the one developed in Fernandez and Fernandez-Grela (2003). The results obtained allow to reach some conclusions about the adequateness of the cluster initiatives process launched in Kazakhstan in 2005 to increase competitiveness and diversify the economy of the country through gradual movement from the extracting of raw materials to high value-added production. Finally, in the third and last stage factor analysis methods are applied to the input-output table in order to check the robustness of the results obtained in the previous stage.

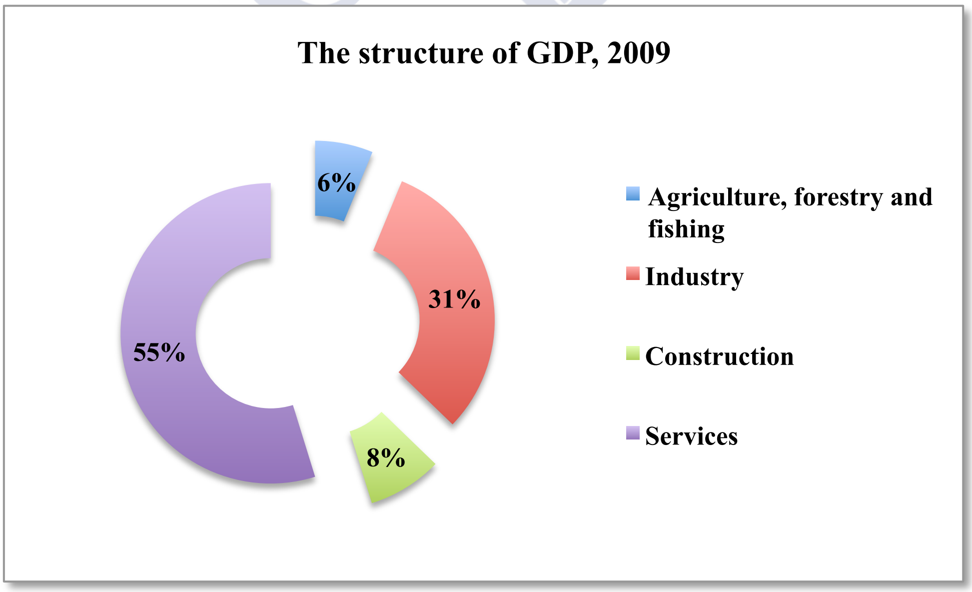
Introduction

Kazakhstan overview

The Republic of Kazakhstan lies between two worlds Europe and Asia. The territory of the country stretches on 2,717,300 square km, which is greater than Western Europe in its entirety. Kazakhstan is bordered with two great powers: Russia on the north, China on the east; and with Kyrgyzstan, Uzbekistan and Turkmenistan on the south. Despite its enormous size, the population density is less than six people per square km, for comparison Spain has 93 per square km (World Atlas, 2010).

Economy of Kazakhstan mainly is based on the extraction of natural resources such as crude oil and other metal products. Therefore, industry sector is occupied approximately 34 per cent of GDP, in 2010. On the other hand, agriculture and construction take only 5 and 8 per cent of GDP, respectively, and production of services – 53 per cent (*Figure **2***). However, the industry sector is characterized by the lack of high value-added production.

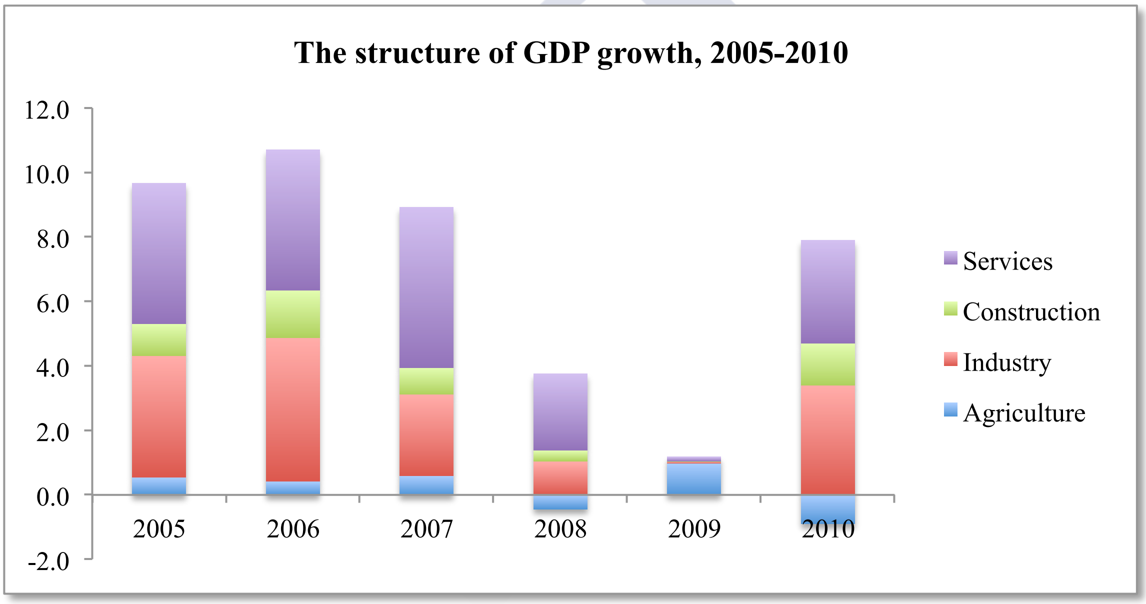
Figure 2: The Structure Of GDP



Source: Own elaboration based on the data of the Agency of Statistics of the Republic of Kazakhstan

As you can see on the *Figure 3*, GDP growth is not stable for the last 10 years. The economy of Kazakhstan had the pick of growth in 2006, as a result of price increase on crude oil in this year. The extracting of gas and crude oil is one of the main sources of state budget replenishment. Since the start of world financial crisis economy of Kazakhstan has endured hard time. Construction sector was the most affected sector. If in 2005 the growth in construction sector achieved almost 40 per cent, then in 2008 it hardly increased by 4 per cent. The stable growth of 2010 year was solely driven by industry sector. It reached the point of 10 per cent. Since 2010, manufacturing has expanded by 18,4 per cent and mining and quarrying by 5,2 per cent. Due to damage from severe summer droughts, agriculture contracted by 11,6 per cent.

Figure 3: The Structure Of GDP Growth, 2005-2010



Source: Own elaboration based on the data of the Agency of Statistics of the Republic of Kazakhstan

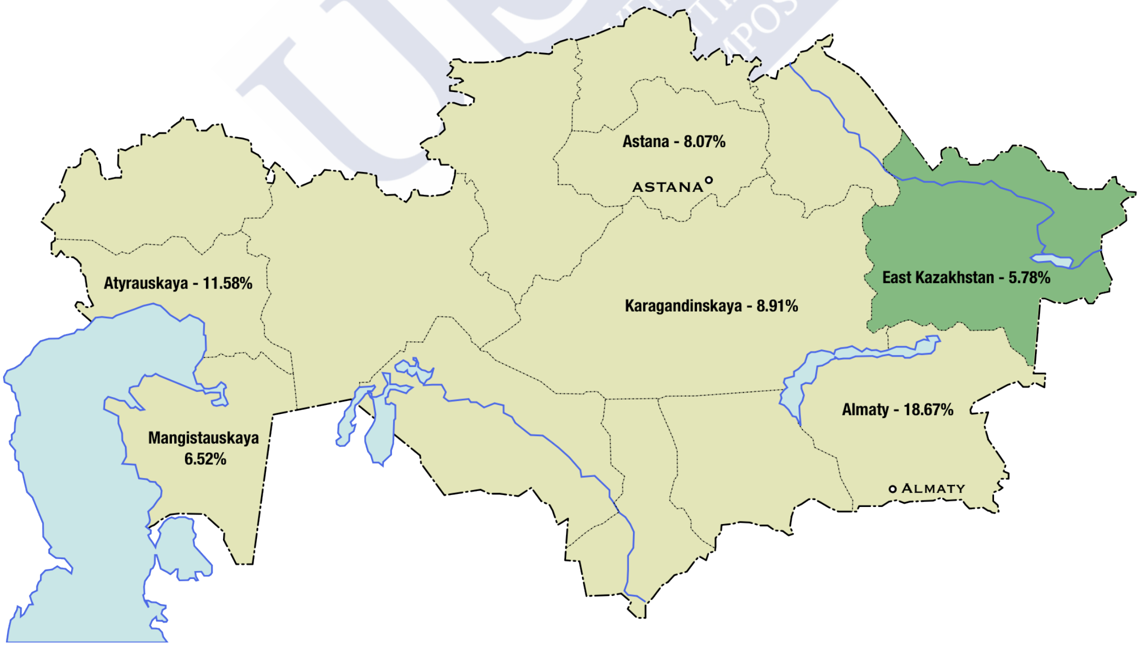
History and development of the Metallurgical Sector in the East Kazakhstan Region

Considerably large and relatively developed facilities of metallurgical complex originate from Soviet Union time. Since the beginning of Second World War, many factories with a specialized workforce were transferred deep into Soviet country, far away from fascists. The East region was an appropriate place with a rich resource deposits and acceptable remoteness. Therefore, the region inherited a good facility of extracting metallurgical raw materials as well as specialized infrastructure and local networking.

The metallurgical complex was formed on the basis of domestic strengths, since Kazakhstan has the largest world's reserves of zinc, tungsten, vanadium, and barite ore, the second largest world's reserves of chrome, phosphate and uranium ores, and the third largest world's reserves of copper, silver, lead and zinc. Kazakhstan ranks also the fourth in world's reserves of molybdenum, the sixth in gold reserves, and the eighth in world's reserves of iron ore. In the underground of the country are estimated to lie 50 percent of the world's tungsten, 23 percent of the world's chrome ore, 19 per cent of world's lead, 13 percent of world's zinc, and 10 percent of global reserves of copper and iron.

East Kazakhstan is one of the industrial developed regions of the Republic of Kazakhstan. In 2009, industrial output achieved 492.1 billion tenge, which is 5,4% of total country´s output. The East Kazakhstan region ranks sixth in regional Gross Domestic Product (GDP) after Almaty city (18,67%), Atyrau region (11,58%), Karaganda region (8,91%), and Mangistau (6,52%) (*Figure **4***).

Figure 4: GDP Shares Of Regions



Source: Own elaboration based on the data of the Agency of Statistics of the Republic of Kazakhstan

As it is shown on the *Table **1***, region was significantly affected by World financial crisis in 2008. There is noticeable decline of all indicators in 2008 and 2009 was provoked by the world financial crisis. The indicator of industry sector responded faster on overall economical comedown than agricultural and foreign trade. However, since 2009 almost the indicators have had positive trend, except the number of existing small enterprises. Average monthly wage of the region is considerably lower than that of the country. But unemployment rate in the region is less than that in the country in average. As we can seen, there is big lag between the number of registered and existing small enterprises.

Table 1: The Key Indicators Of The Region, 2006-2011

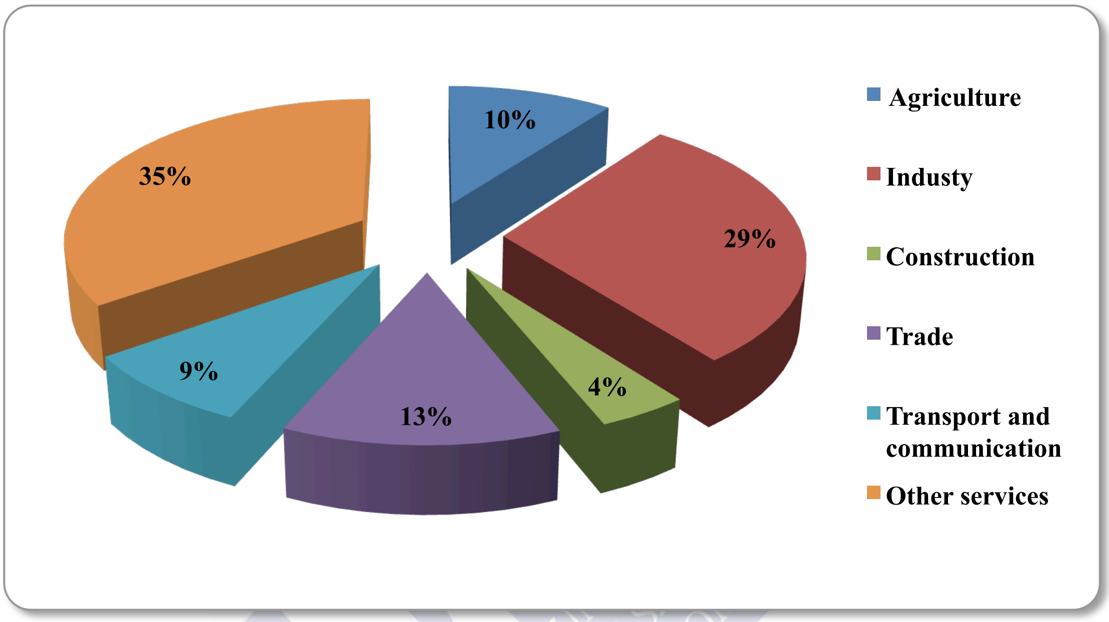
Indicators	unit	2006	2007	2008	2009	2010	2011	% weight or +,- deviation
GDP	billion tenge	615,1	800,5	890	983,7	1244,1	1,624,3	5,9
Industrial output	billion tenge	410,1	481,1	469,5	492,1	641,2	822,9	5,3
Gross agriculture production	billion tenge	80,3	98,5	110,2	165	153,1	202,2	8,8
Foreign trade turnover	million dollars	2535,9	3385	3140	2700	2988,1		3,9
Fixed investments	billion tenge	116,1	126,5	161,4	139,2	144,6	241,6	4,8
The number of registered small enterprises	units	10668	11232	11786	12006	12096	12285	5,9
The number of existing small enterprises	units	7662	7891	6998	7482	7308	6421	5,8
Average monthly wage	tenge	33101	42138	48293	53496	61388	73677	-16351
Unemployment rate	%	6,9	6,6	6,4	6,4	5,7	5,2	-0,2
Consumer price index	%	107,5	116,1	110,5	105,7	108,1	107,1	0,3

*weight of 2011 year

Source: Own elaboration based on the data of the Agency of Statistics of the Republic of Kazakhstan

Non-ferrous metallurgy is prevalent sector of the region, as well as machinery and metal processing, energy, forestry and woodworking, light and food industries. The *Figure **5*** confirms the industrial orientation of the East region. Industry with approximately 29 % share in region´s GDP, contributes considerably to the economy of region. Industrial specialization is highly promoted by local and central government.

Figure 5: Gross Regional Product By Types Of Economic Activity, 2009



Source: Own elaboration based on the data of the Agency of Statistics of the Republic of Kazakhstan

The region has significant reserves of polymetal ores containing zinc, lead, copper, rare and precious metals. There are some deposits of coal in Semey and Zaysan regions. The region also has considerable reserves of gold, rare metals and raw materials to produce cement, slag glass, slate and zeolite.

East Kazakhstan is one of the main producers of lead, zinc and copper in concentrates, refined gold and silver in the Republic, and the only one in production of titanium, magnesium, tantalum and fuel for nuclear power plants. The share of region´s manufactured lead in total Republic output is 88 %, copper-zinc ores - 95.4%, zinc – 89 %, and titanium - 100%. The firms of non-ferrous metallurgy produce more than a half of the total industrial output of the region.

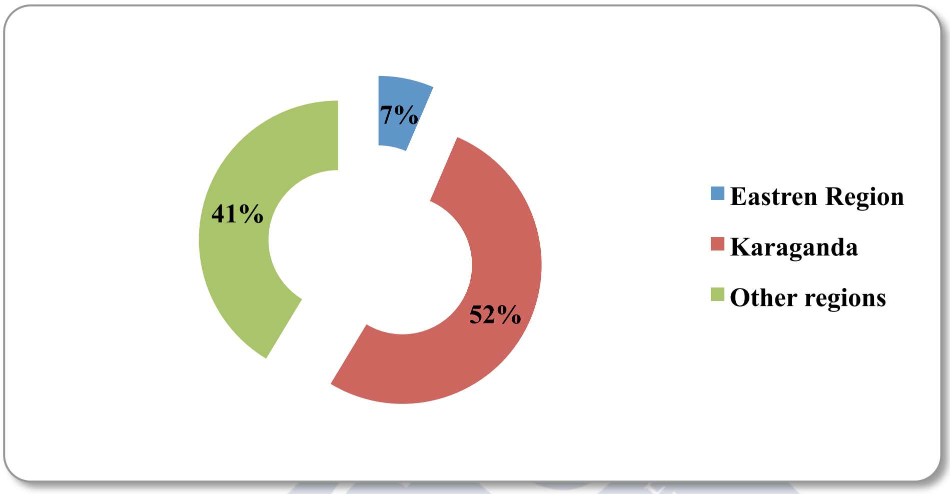
The largest industrial joint-stock companies are "Kazzinc", "Ust-Kamenogorsk Titanium Magnesium Plant", "UMP", Association "Vostokkazmed" as a branch of "Kazakhmys" corporation. Machinery sector is represented by large enterprises, such as: JSC "Asia Auto", JSC "Vostokmashzavod", JSC "Ust-Kamenogorsk Valve Plant", JSC "Ust-Kamenogorsk Condenser Plant", JSC "Semipalatinsk Engineering Plant", JSC "Irtyshtsvetmetremont", "Mashzavod" LLP, "Kazelektromash" LLP, "George plant pumping equipment." They produce the car "Niva», «Skoda», mining equipment, mineral processing equipment, oil and gas fittings, household electric motors and pumps with various modifications, capacitors and other electrical and cable products (Восточно-Казахстанская область : Экономика, 2007).

Background of cluster policy

Due to the strong dependence of the economy on extraction of natural resources, in 2005, the government of Kazakhstan approved the plan to create and develop seven pilot clusters. The Centre for Marketing and Analytical Research of the Republic of Kazakhstan developed the project together with foreign consulting firms JE Austin Associates, and Economic Competitiveness Group. The goal of the project is to increase the competitiveness of sectors that are not related to the extraction of natural resources. During the first phase of the clusterization, special groups studied fifty five thousand companies, in forty-six industries in twelve regions of the country. Because of resource and financial restrictions, the government determined a limited number of clusters, which are considered the most meaningful for economic development. Seven pilot clusters were selected, including transport and logistics services, tourism, oil and gas machinery, construction materials, food and textile industries, and metallurgy. Some of them were in a more developed stage, while others needed to start from scratch.

Geographical concentration was one of the criteria used in industry selection, as well as the critical mass of existing companies in the industry. The metallurgical cluster has been basically initiated in the central region of Kazakhstan, because a significant proportion of metallurgical output is located in that area. However, there are significant metallurgical complexes in the eastern part of Kazakhstan, which are also included in the cluster. Copper, zinc and lead concentrate are the main metallic products produced in the East Region. Despite the fact that the metallurgical cluster includes complexes in the Karaganda and Eastern regions, our research is focused only on the Eastern region metallurgical complex (*Figure 6*). Both complexes have a different specialization and different target markets, which gives us a possibility to consider these regions separately.

Figure 6: Share Of Metallurgical Cluster In Total Metallurgical Output, 2009



Source: Own elaboration based on the data of the Agency of Statistics of the Republic of Kazakhstan

The metallurgical cluster in Kazakhstan conforms to the concept of "vertical cluster" described in Blum (2008) as a spatial hub that dominates suppliers settled in the vicinity. It is structured through centralized networks that profit from agglomeration economies and economies of scale external to the firms, and from low transaction and physical transport costs upstream and downstream the value chain. In many cases, initially vertical integrated firms become more flexible by means of outsourcing activities. "Outsourcing of non-core activities has been chosen by Kazzinc as part of its streamlining strategy. The spin-off of auxiliary operations to create new entities encourages their development by means of turning them into stand-alone profit centres" (The specialized industrial complexes and subsidiaries, 2010). Usually, vertical clusters are based on "backward linkages", and innovations are concentrated in the head of cluster. Core competences mostly rest on the demand side and vertically oriented research is directed to the needs of the market.

Despite the fact that the mining and manufacturing of non-ferrous metals are concentrated in the East Region, other types of metals such as copper and aluminium are dispersed over the big territory of Kazakhstan. Because of this metallurgical cluster captures only approximately 6 per cent of total metallurgical output. Total metallurgical output accounts to 10 % and 13 % of total manufacturing and mining output, respectively. Cluster´s firms produce the half of them (*Table **2***)

Table 2: The Indexes of Metallurgical Sector And Cluster, 2009

Indexes	Cluster	Sector
Share in Total Manufacturing Output	5,95%	10%
Share in Total Mining Output	6,61%	13%

Source: Own elaboration based on the data of the Agency of Statistics of the Republic of Kazakhstan

The majority of metallurgical production is unwrought and semi-manufactured outputs. Due to the lack of specialized facilities, almost all extracted metals and metal products are exported abroad for further processing. Moreover, existing production facilities have a high degree of environmental pollution and technological backwardness. The majority of them were commissioned in the Soviet Union period and since then have not had significant technological upgrade. In the region there is no facilities for utilisation of industrial residuals, it simply discharged to the sewer. For instance, the waste pond belonging to "Ust-Kamenogorsk Capacitors Plant" is not fenced. Its protections arrangements are purely nominal and nobody monitor pollutant there. The country lacks laws and regulations on safe management and pollution restrictions. Therefore, companies do not utilise contaminated installations to meet environmental protection criteria. Industrial companies are not interested in provision of information on contamination to the public or in some cases they even hidden it.

According the manual developed by the Environmental Directorate of East Kazakhstan Oblast in the framework of a joint MoE-UNDP project, obsolete PCBs-containing equipment was found at facilities of "Kazzink" and "Kazakhmys" and it still used at Ust-Kamenogorsk Titanium and Magnesium Plant". The health effect of PCB exposure involves damage to the liver, thyroid, and immune system along with reduced birth weight, reproductive toxicity, alteration of neurodevelopment, and cancer. The PCBs level in soils reaches 7-4 mg/kg, compared to the relevant regulatory maximal acceptable concentration (MAC) of 0.06 mg/kg (Astanina, 2006).

In order to accomplish strategic goal to diversify the economy through the development of clusters, the government approved the Program of Industrial and Innovation Development 2004-2015 (Program of Industrial and Innovation Development 2004-2015). The program contains the plan of actions for a successful diversification. Due to the industrial specialization of the East Region, the program has been focused on the development of high-value production of metallurgical complex. The goal of program is to achieve the sustainable development of the region through diversification, which means gradual movement from extracting of raw materials to production of high-tech outputs.

Very optimistic aims are based on three main directions: the support of small private business; the expansion of manufacturing share in total industrial output and the development of scientific and innovation potential. However, only 8 % of industrial output is produced by small enterprises instead of 25%, tasked by the program, in 2009. Government planed to achieve 80% of manufacturing share in total industrial output. By now, its share grew from 71 % in 2009 to 76 % in 2011. The share of industrial output in regional GDP is supposed to be increased to 50 % (30% in 2009 year).

Joint Stock Company Sovereign Wealth "Samruk-Kazyna" holding is responsible institution for the financial support and practical realisation of program at national level (Informational and analytical portal of «Sovereign wealth fund "Samruk-Kazina" JSC, 2009). According to preliminary estimates, the ratio of public and private capital should be one to two. In 2009, government invested approximately 500 billion tenge in the development of metallurgical cluster (1 dollar is approximately 145 tenge, 2009). The own funds of enterprises stay the main source of capital investments, around 70 percent (103 million tenge) in 2010. The structure of capital investments of region is 20% (30308,7 million tenge) are coming from central government, 3,6% (5451,2 million tenge) - local government, 1,4% (2078,4 million tenge) – foreign capital and 6,5% (9769,3 million tenge) borrowed funds.

The biggest capital investments are observed in manufacturing (31,3%) and mining and quarrying (16.0%) sectors. In contrary, agriculture, forestry and fisheries and construction sectors insignificantly invest in capital. Manufacturing sector cut capital investment by 11% in 2010, whereas mining invested by 2% more than in previous year. Investments in mining sector come from own fund of firms (88 %) and insignificant part from borrowed funds and government (Statistics Department of East Kazakhstan region, 2009).

International experience has demonstrated that stock market is one of the justifiable ways to attract foreign investments. Since 2007, five companies located in East Kazakhstan have entered in the stock market, including “Ulba Metallurgical Plant” and “Ust-Kamenogorsk Titan-Magnesium Plant”. In addition, in the framework of the Industrial Innovative Program, 21 investment projects were approved and funded by the “Samruk-Kazyna” JSC. East Kazakhstan takes the fifth place among the regions by the number of implemented projects with the participation of public development institutions. In order to support competitive enterprises, local authorities established industrial zones with proper infrastructure and equipped facilities. Approximately 763 million were allocated to accomplish this purpose. Nevertheless, entrepreneurs complain about the opacity of procedures and the long duration of the timing to review projects. In practice, a project gets funded no earlier than one year from the date of filing an application to development institutions.

Metallurgical cluster is mainly represented by large enterprises with more than 250 employees. Three companies, "Kazzink" JSC, "Ust-Kamenogorsk titan and magnesium complex" JSC and "Ulba metallurgical plant" JSC produce more than a half of total industrial output. According to the Department of Statistics of East Kazakhstan Region, 123 private firms operate in this sector, including 111 small and medium enterprises and 12 large size firms (*Table **3***).

Table 3: The Number Of Metallurgical Firms By Size And Sector, 2009

Sector	Small	Medium	Big
Mining sector			
Extraction of fuel and energy minerals	28	10	2
Manufacturing sector			
Metallurgy and production of metal products	64	9	10

Source: Own elaboration based on the data of the Department of Statistics of the East Kazakhstan Region

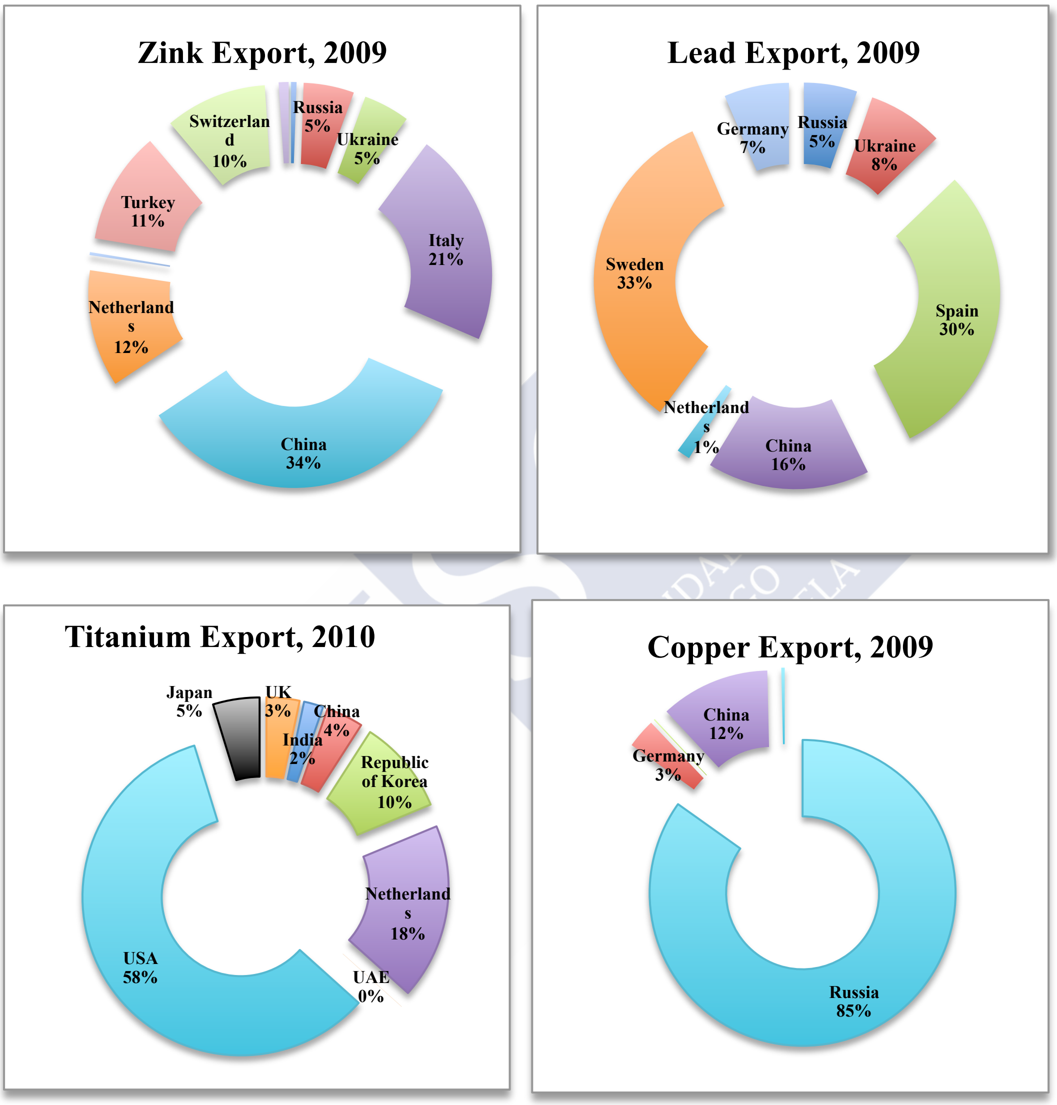
Table 4: Output Of Metallurgical Cluster In Eastern Region, 2009

Output	
Mining, ton	
Copper ore	351000
Copper concentrate	888300
Copper in copper concentrate	172900
Copper-zinc ore	4853400
Gold-bearing ore	4878100
Gold-bearing concentrate	167700
Lead concentrate	61900
Lead in lead concentrate	35500
Lead-zinc ore	5734200
Zinc concentrate	698500
Zinc in zinc concentrate	374900
Manufacturing and production of metal products	
Ferrous metallurgy	
Crude steel, ton	9174
Stainless steel in ingots or other primary forms and semi-finished products of stainless steel, ton	10174
Electric carbon steel, ton	1772
Nonferrous metallurgy	
Silver, kg	100,173
Gold, kg	12,556
Lead, ton	320269
Other non-ferrous metals, ton	36914
Casting	
Casting of iron, ton	2671
Casting of steel, ton	13560
Casting of other non-ferrous metals, ton	92
Production of metal products	
Construction metal products, ton	7065
Other metal products, items	24

Source: Own elaboration based on the data of the Department of Statistics of the East Kazakhstan Region

Third part of all employees is referred to industrial employment. The third highest nominal wage is in mining sector after financial and information & communication sectors. The majority of employees in the mining sector prefer to work in large size firms due to higher wages and social infrastructure (kindergarten, medical service and etc.). However, there is the high risk of adverse health from direct exposure of heavy metals.

Figure 7: Export Of Main Metals, 2010



Source: Own elaboration based on the data of the Customs Control Committee under the Ministry of Finance of the Republic of Kazakhstan

The total output of the mining sector is approximately 18 million ton of metal ores (*Table 4*). Lead-zinc ores occupy the largest share of total production, being copper-zinc and gold-bearing ores the second and third largest, respectively.

More than a half of produced zinc exports to Italy and China. Approximately equal percentage of zinc export is going to Netherlands, Turkey and Switzerland (*Figure 7*).

The zinc sold domestically is used mainly to produce galvanized steel at Mittal Steel Temirtau (Karaganda). The main zinc-producer in Kazakhstan is “Kazzinc” company. Its share accounts to 87 per cent of all produced zinc in the country.

Kazakhstan's proven reserves of lead are estimated at 11.7 million tons (or 10,1% of world reserves) (Цветная металлургия Республики Казахстан, 2007). Kazakhstan ranks sixth place in lead reserves after Russia, Australia, Canada, USA and China. “Kazzinc” provides over 58 per cent of lead in lead concentrate produced in the country. As well as other metals, the majority of production is exporting. The main buyers of lead are Sweden, Spain and China (*Figure 7*).

Produced titanium sponge is fully intended for export to USA, Netherlands, UK, Republic of Korea and other countries (*Figure 7*). The shipment is mainly accomplished by long-term contracts (in particular, by RMI Titanium Co.). It is estimated that "Ust-Kamenogorsk titan and magnesium complex" captures almost the half of the US market of titanium sponge and a 20 per cent of the global market. “Michael Levi, the representative of American company Timet, has declared, "deliveries from Kazakhstan accounts for more than half of national import ". As a result the American manufacturers of the titanium insist on imposition of 15% duty on production of Ust-Kamenogorsk titanium-magnesium factory” (Nikolaev, 2003).

Proven reserves of copper in Kazakhstan are estimated at 37 million tons (or 5,5 percent of world reserves) (Цветная металлургия Республики Казахстан, 2007). Kazakhstan is among the top countries of copper producers. Copper is mainly exported to Russia and China (Figure 6). Beryllium products are supplied mainly for export to the U.S., Europe, China, Japan and Russia (Metallurgy of Kazakhstan, 2007).

The purpose of this chapter is to identify industrial clusters in the Eastern region of the Republic of Kazakhstan. Our research proceeds in two stages. Since only national input-output table is available, at the first stage we discuss several methods of regionalization available. As the second stage we apply methods of cluster identification at regional level, using regionalized input-output table.

1.1. Regionalization of national input-output table

For the empirical part of paper we use the Input-Output Table, which reflects the flow of goods and services on the economy of Kazakhstan in 2009. The table is available on the webpage of The Agency of Statistics of the Republic of Kazakhstan. The Input-Output Table of Kazakhstan is aggregated from extended matrix of 714×164 to the symmetric matrix of 58 sectors. The data is represented in national currency, tenge. In case of Kazakhstan as in majority of countries, only national input-output table is available. However, regional studies suggest several methods to regionalize the national table using some coefficients.

Let's denote the regional technical coefficient matrix by $A^{rr} = \left[a_{ij}^{rr}\right]$, where a_{ij}^{rr} is the amount of inputs from sector i in the region r per tenge's (national currency) worth of output of sector j in the region r.

Based on the assumption that local producers use the same production recipes as are shown in the national coefficient matrix, we consider that the technology of production in each sector in region r is the same as in the nation as a whole. However, in order to translate regional final demands into outputs of regional firms x^{rr}, the national coefficient matrix will be modified to A^{rr}.

Early studies of regional economics suggest using *regional supply percentage* in order to modify national matrix.

$$p_i^r = \frac{\left(x_i^r - e_i^r\right)}{\left(x_i^r - e_i^r - m_i^r\right)},$$

where x_i^r is the total regional output of each sector i, e_i^r is the export of the product of each sector i from the region r and m_i^r is the import of good i into region r. If we can estimate p_i^r for each sector in the economy, then each element in the i_{th} row of the national coefficient matrix multiply by p_i^r, we construct a row of locally produced direct input coefficient of good i to each local producer.

The equation for two-sector model is:

$$A_{rr} = \hat{p}^r A = \begin{bmatrix} p_1^r & 0 \\ 0 & p_2^r \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} = \begin{bmatrix} p_1^r a_{11} & p_1^r a_{12} \\ p_2^r a_{21} & p_2^r a_{22} \end{bmatrix}$$

However, the assumption made is quite strong. *It means, for example, that if the aircraft, kitchen equipment, and pleasure boat sectors in Washington all use aluminum (sector* i*) as an input, all three sectors buy the same percentage,* p_i^r*, of their total aluminum needs from firms located within the state* (Miller & Blair, 2009). Another problem is the availability intra- and interregional data that is needed to adjust national matrix to regional input-output model.

There are several methods of regionalization through adjustments based on employment data, income or output by industry. Nevertheless, than more speculations are made and more comprehensive method than more regional data you need.

Simple Location Quotients

If the x_i^r is the gross output of sector i in region r and x^r is a total output of all sector in the region r, and x_i^n and x^n are these totals at the national level, then the simple location quotient for sector i in region r is defined as

$$LQ_i^r = \frac{\left(x_i^r / x_i^n\right)}{\left(x_r / x_n\right)}$$

or

$$LQ_i^r = \left(\frac{x_i^r / x^r}{x_i^n / x^n}\right)$$

The numerator represents the proportion of sector i in total output of region r. The denominator shows us the national proportion of the same sector i in total output of the country. From this it follows that if $LQ^r > 1$ sector i is more localized in the region r than in the country as whole. Conversely, if $LQ^r < 1$ sector i is less concentrated in the region r than in the country as whole. In case if a national sector is not present in the region, i.e. $LQ^r = 0$, that column and row are simply deleted from regional matrix.

The same quotients are derived from other measures of regional and national economic activity such as employment, personal income earned, valued added and so on.

Beside the product-mix issue that was discussed before, this approach has a cross-hauling problem, where region export and import the same goods. According to *LQ* approach the region can either net exporter or net importer of a particular good. However, region can export one product and import another within the same sector, which is understand by approach as the same good since in the same sector. *It leads to a tendency for underestimation of interregional trade and thus for overestimation of intraregional economic activity, and therefore it also tends to generate regional multipliers that are too large* (Miller & Blair, 2009).

The simple modification are made to eliminate those sectors that not use good of sector i as input.

$$PLQ_i^r = \left(\frac{x_i^r / x^{*r}}{x_i^n / x^{*n}}\right),$$

where x_i^r is regional output of sector i and x^{*r} is a total regional output of only those sectors that use good of sector i as input. x_i^n and x^{*n} are national output of sector i and total output of those sectors that use i as input, respectively.

Cross-Industry Quotients

If previous approach modifies national coefficients by rows, the cross-industry approach makes cell-by-cell adjustments within A^n.

$$CIQ_{ij}^r = \left(\frac{x_i^r / x_i^n}{x_j^r / x_j^n}\right)$$

and

$$a_{ij}^{rr} = \begin{cases} \left(CIQ_{ij}^{r}\right) a_{ij}^{n} & \text{if } CIQ_{ij}^{r} < 1 \\ a_{ij}^{n} & \text{if } CIQ_{ij}^{r} \geq 1 \end{cases}$$

If the output of regional sector i relative to the national output of sector i is larger than output of regional sector j relative to the national output of sector j, i.e. when $CIQ_{ij}^{r} > 1$, then all need's of sector j in input i can be supplied from within the region. Conversely, if $CIQ_{ij}^{r} < 1$ then some of need's of sector j has to be imported. Two features are valid for this approach $CIQ_{ij}^{r} = LQ_{i}^{r} / LQ_{j}^{r}$ and $CIQ_{ij}^{r} = 1$ along the main diagonal.

The Semilogarithmic Quotient and its Variants

The Cross-Industry Quotients approach includes relative sizes of both selling (x_{i}^{r} / x_{i}^{n}) and buying $\left(x_{j}^{r} / x_{j}^{n}\right)$ sectors but not contains relative size of region $\left(x^{r} / x^{n}\right)$. Flegg & Webber (1997) proposed to modify the Semilogarithmic Quotient approach that takes into account all three measures, where

$$FLQ_{ij}^{r} = (\lambda) CIQ_{ij}^{r}$$

where $\lambda = \left\{\log_2\left[1 + \left(x_{E}^{r} / x_{E}^{n}\right)\right]\right\}^{\delta}$, $0 \leq \delta < 1$ (empirical work suggested that $\delta = 0{,}3$) (Flegg & Webber, 1997)

so,

$$a_{ij}^{rr} = \begin{cases} \left(FLQ_{ij}^{r}\right) a_{ij}^{n} & \text{if } FLQ_{ij}^{r} < 1 \\ a_{ij}^{n} & \text{if } FLQ_{ij}^{r} \geq 1 \end{cases}$$

Flegg and Webber (1997) use employment as a measure of relative size of region (x_{E}^{r} / x_{E}^{n}).

Above-mentioned approaches are most frequently used and applied methods in regional economics (Miller & Blair, 2009). However, there are more methods slightly modified or methods using the value added, export-import information and so on.

Since the Semilogarithmic Quotient approach has relative advantages among other methods and due to data constraints we decided to apply this approach.

Application of Semilogarithmic Quotient approach and results

National Input-Output Table of Kazakhstan includes 58 sectors (The Agency of Statistics of the Republic of Kazakhstan, 2010). By multiplying each coefficient of national matrix by obtained Semilogarithmic Quotient's matrix, we reduced matrix to 39 sectors. In case when sector is not presented in the region, FLQ = 0, column and row were simply deleted.

At the second stage, we applied two methods of cluster identification. One of them is based on the estimation of strength of forward and backward linkages and other one includes factor analysis. However, both of them use the input-output tables in empirical analysis of cluster identification.

Interregional model

Regional IOT incorporate information about inter-industry relationships within a particular region. It is useful tools to measure the total effect that an initial change in economic activity has on a local economy. However, the regional model is limited to show the interconnections between regions and spillover effects (Bess & Ambargis, 2011). As a result, intraregional model might miss those cluster that cross regional boundaries. Hofe & Dev Bhatta (2007) argue that is impossible to study clusters isolated from surrounding national economy. On the other side, multiregional model is data intensive. It requires a lot of detailed intra- and interregional information. For example, two-region model (the region and the rest of the country) involves two matrices estimating the transaction between two regions; three-region model has 6 matrixes and 12 matrixes are needed for four-region model. This information is not always available.

Two-region model allows to measure the spillover effect and to which extent the East Region is interconnected with the rest of country. Let´s denote r to the East Region and s to the rest of the country. In our case, complete coefficient matrix of two-region model consists of the four submatrices. Each of four matrixes have $n \times n$ the dimension, where n the number of industries.

$$A = \begin{bmatrix} A^{rr} & A^{rs} \\ A^{sr} & A^{ss} \end{bmatrix}$$

where

A^{rr} is the intraregional input coefficient matrix for region r, the East Region;

A^{ss} is the intraregional input coefficient matrix for the rest of country;

A^{rs} is the interregional trade coefficient matrix which represent "export" from region r and in the same time "import" to the rest of county. It is common practice in regional input-output work to use the terms export and import as a trade that crosses regional boundaries (Miller & Blair, 1985).

A^{sr} is the interregional trade coefficient matrix which represent interregional trade flows from the rest of country to region r.

It is important to bear in mind the stability of intraregional (A^{rr} A^{ss}) and interregional (A^{rs} A^{sr}) input coefficients when using the interregional model. Although interregional model reflects trade relationship between regions, the constancy of these relationships is not easy to accept. Data availability allows us to construct only (A^{rr} A^{ss}) matrixes, deriving them from national IOT. (A^{rs} A^{sr}) are the most problematic in terms of data intensity. In Kazakhstan, there is no trade flows registration between regions. The territory of the country is considered as whole entity. Products are going to and from abroad only way to register trade flows. Therefore, the reliable construction of interregional model for Kazakhstan is not possible.

1.2. Identification of clusters

Rasmussen's method

There is a large number of cluster identification methodologies, for example industry-based input-output relationships, industry growth forecasts, case studies, shift-share analysis and location quotients. However, one of the well-known and applied methods is the estimation of forward and backward linkages based on the Leontief input-output table. The idea of linkages was introduced by Rasmussen in 1956 and subsequently suggested as a tool of key sector identification by Hirschman (1958). Input-output analysis is a method to identify relationships between different actors within regional or national economies. It helps to determine the financial impacts for a certain policy change and its effects on the whole economy. Comparison of forward and backward linkages determines "greater than average impact upon an economy", so a relatively small number of industries, amplifying initially small changes, eventually affect the whole economy (Hewings, 1982). The idea of inter-industry linkages was further elaborated and applied by several authors such as Sonis and Hewings (1999), Rimbler et al (2000), Aroca (2001), Hazari (1970), and others.

The backward linkages indicate the interconnection of a particular sector to those sectors from which it purchases inputs (Miller & Blair, 1985). If a sector j increases its output, there will be increased demands from sector j, as a purchaser, on the sectors whose products are used as inputs to production in j (Cristobal & Biezma, 2006). The backward linkages include the direct and indirect effect of all industries that provide the intermediate inputs necessary for the production of a particular industry being invested (Kim, Sohn, & Whang, 2002). It is a measure that is expressed in terms of a sector's use of inputs from other sectors in the economy.

The forward linkages indicate the interconnection of a particular sector to those sectors to which it sells its output (Miller & Blair, 1985). If a sector j increases its output, it means additional amounts of product j that are available to be used as inputs to other sectors for their own production (Cristobal & Biezma, 2006). So, will be increased supplies from the sector j, as a seller, for the sectors, which use goods j in their production.

The output level X's required to satisfy a given vector of final demand F in the input-output model are determined by the following equation:

$$X = (A - I)^{-1} F$$

where $(A - I)^{-1} = L$ is the Leontief inverse matrix.

Let us denote the typical element of the $(A - I)^{-1}$ matrix by b_{ij}. Then $B_{.j}$ and $B_{i.}$ are the sum of the column and row elements.

$$B_{.J} = \sum_{i=1}^{n} b_{ij}$$

indicates the total input requirements for a unit increase in the final demand for the j^{th} sector.

Similarly,

$$B_{i.} = \sum_{j=1}^{n} b_{ij}$$

indicates the increase of the output of sector number i needed to cope with a unit increase in the final demand of all industries.

If the $\bar{B}$ as an average, unweighted value of an element in the inverse matrix, then the indices will be developed as follows:

Power of dispersion: $U_j = \left[B_{.j}/n\right]/\overline{B_J}$

Sensitivity of dispersion: $U_i = [B_{i.}/n]/\overline{B_\iota}$

U_J and U_i can be also interpreted as Hirschman's backward and forward linkages.

Since the averages $\overline{B_J}$ have been interpreted earlier showing the requirements of inputs if the final demand of industry number j increases by 1 unit, a unit change in final demand in a sector where $U_j > 1$ will thus generate an above average increase in activity in whole economy (Hewings, 1982). In the same way, $U_i > 1$ indicates that the industry number i will have to increase its output more than others for a unit increase in the final demand from the whole system (Hazari, 1970).

However, many authors complained that averaging method is sensitive to extreme values and may give false results. Therefore, Hazari (1970) one of the first, proposed to use the indices of coefficient of variation.

$$V_J = \sigma_J / \overline{b_J}$$

And

$$V_j = \sigma_j / \overline{b_\iota}$$

where the σ_j and σ_i are the standard deviation of the j column elements and i row elements. The denominators, $\overline{b_J}$ and $\overline{b_\iota}$ are the column and row means.

The high indices of coefficient of variation show that a particular industry draws heavily on one or few sectors. On the other hand, low indices can interpreted as industry drawing evenly from the other sectors.

Consequently, key sectors can be defined as

a. Where both $U_J > 1$ and $U_i > 1$;
b. Where both V_J and V_i are relatively low.

Rasmussen approach takes into account both direct and indirect effects. However, Jones (1976) argued that the forward linkages show the impacts when the final demand of each single sector increases by one unit. While not all sectors provide the same equal part of their output to other sectors. It can lead to a large Leontief inverse row sums and to the overestimated impacts of some sectors on the final demand. In order to solve this problem, Jones proposed to use the row sum of output inverse matrix derived from the output coefficient matrix as a better indicator of forward linkages (Munday, Jones, & Malcolm, 2009).

Hazari method

According to Rasmussen method, all sectors or industries are of equal importance in the economy and have an equal share in the estimation of forward and backward linkages. However, Hazari insists that some weights procedure has to be applied for bringing out the relative importance of the various sectors in the economy (Hazari, 1970). There are different measures of weighting industries according to their relative importance; its selection depends on the objective function of the planner. Hazari called this “policy´s makers preference function”. Foe example, in the identification of key sectors in Indian economy, he used final demand of particular sector as a proportion of the total final demand.

Backward linkage is determined by the following equation:

$$Z_j = \sum_{i=1}^{n} K_{ij} F_j$$

and forward linkage is

$$Z_i = \sum_{j=1}^{n} K_{ij} F_i$$

where K_{ij} is the elements of the inverse of $(I - A)$ and F is the final demand.

Then, in order to discriminate against sectors that are too small, let weight the backward and forward linkages according to final demand shares of sectors.

$\lambda_j = Z_j W_i$ where $W_i = \dfrac{F_i}{\sum_{i=1}^{n} F_i}$

and

$\lambda_i = Z_i W_i$ where $W_i = \frac{F_i}{\sum_{i=1}^{n} F_i}$

By the Hazari approach sectors in which both Z_j and Z_i are high relative to others and both λ_j and λ_i are high can be defined as a *key sectors from the point of view of the importance of each sector in the economy as a contributor to final demand* (Hazari, 1970).

However, final demand is not a homogeneous aggregate therefore a simple relative share of sector to final demand could not measure its impact on the economy. In addition, *final demand comprised of different components; it is highly unlikely that the impact of each component be equal to that of another component* (Pirasteh & Karimi, 2005).

Later, Jones (1976) Laumas (1976) proposed to use the primary inputs as the weight for forward linkage and the share of sectors in the final demand as the weight of backward linkage.

So, the backward linkage is defined as

$$BL_j^w = \sum_{i=1}^{n} k_{ij}^w = B_{.j}^w$$

where, $k_{ij}^w = k_{ij} \frac{F_i}{\sum_{i=1}^{n} F_i}$

k_{ij} is the ij^{th} element of Leontief inverse matrix

k_{ij}^w is the weighted ij^{th} element of Leontief inverse matrix

F_i is the final demand

and the forward linkage is defined as

$$FL_i^w = \sum_{i=1}^{n} g_{ij}^w = B_{i.}^w$$

where, $g_{ij}^w = g_{ij} \frac{V_j}{\sum_{j=1}^{n} V_j}$

g_{ij} is the ij^{th} element of Gosh inverse matrix

g_{ij}^w is the ij^{th} element of Gosh inverse matrix

V_j is the value added

Chenery-Watanabe Method

The Chenery-Watanable (1958) model uses the input coefficient matrix A = [a_{ij}].
The backward and forward linkages are defined as column and row sum of input and output coefficients matrix **A**, respectively.

So, the backward linkage is

$$BL_j^{CW} = \sum_{i=1}^{n} \frac{X_{ij}}{x_j} = \sum_{i=1}^{n} a_{ij}$$

and forward linkage is

$$FL_i^{CW} = \sum_{j=1}^{n} \frac{X_{ij}}{x_i} = \sum_{j=1}^{n} b_{ij}$$

The main disadvantage of the Chenery-Watanable method is that it neglects the indirect effects. The method measures only the first round of effects generated by the inter relationships between sectors.

Application of Rasmussen´s method

Taking into account the disadvantages of Chenery-Watanable method and the dependence of Hazari method on the objective function of the planner, we applied the Rasmussen's method to national IOT and to regionalized input-output table of the East Region.

Regional level

As you can see on the *Table **5***, nine sectors were selected as key sectors based on Rasmussen's method. The high forward and backward linkages and low coefficient of variation were detected in the following sectors. If we eliminate local-serving sectors such as Production and distribution of electricity, gas and water, Construction and Manufacture of food products, including beverages "metalworking" cluster has greater than average impact on the economy of the East region, in supporting other industries as well as boosting other industries.

However, not always strong both backward and forward linkages are the indicators of importance of sector in a region. Therefore, usually input-output analysis is usually supplemented by other methods and various combinations among all of them, including employment data of sectors.

Table 5: Key Sectors In The East Region By Rasmussen´s Method

	Key sectors	**Backward linkage**	**Forward linkage**
1	Agriculture, hunting and related service activities	1.12	1.17
2	Forestry	1.06	1.04
3	Manufacture of food products, including beverages	1.02	1.03
4	Manufacture of paper and paper products	1.13	1.06
5	Chemical industry	1.32	1.36
6	Metallurgical industry	1.09	1.79
7	Manufacture of electrical machinery and apparatus	1.04	1.01
8	Production and distribution of electricity, gas and water	1.04	1.37
9	Construction	1.2	1.2

Source: Own elaboration

The *Table **6*** shows sectors in which the backward linkages are high and coefficient of variation is relatively low, excluding local-serving sectors. These sectors are called the backward-linkage-oriented sectors (BLOS) (*Figure **8***). The backward linkage is a measure, which is expressed in terms of sector's use of inputs from other sectors in the economy (Cristobal & Biezma, 2006). The high backward linkage means the high sectors dependence on others in the economy for its inputs, and therefore a high effect on the economy might be expected by the stimulating an increase in this sectors' output.

Table 6: Strong Backward Linkages Sectors With Low Coefficient Of Variation

	Sectors	**Backward linkage**	**Coeff. Of variation**
1	Mining the production of coal dropped, brown coal mining of coal and lignite	1.03	4.77
2	Other mining and quarrying	1.05	4.62
3	Production of textile products	1.03	5.19
4	Publishing, printing and reproduction of recorded media	1.02	4.94
5	Manufacture of rubber and plastic products	1.05	4.69
6	Manufacture of fabricated metal products, except machinery and equipment	1.26	4.09

Source: Own elaboration

The *Table 7* shows us the sectors with high forward linkages and relatively low coefficient of variation, excluding local-serving sectors. They are named by abbreviation FLOS on the Figure 8, which means forward-linkage-oriented sectors. The forward linkages indicate the proportion of sector output that serves as inputs to other sectors of economy. The high forward linkage means the more its output is used as an input to production in the regional economy therefore the more an increase in the regional economy's production would stimulate this sector (Aroca, 2001).

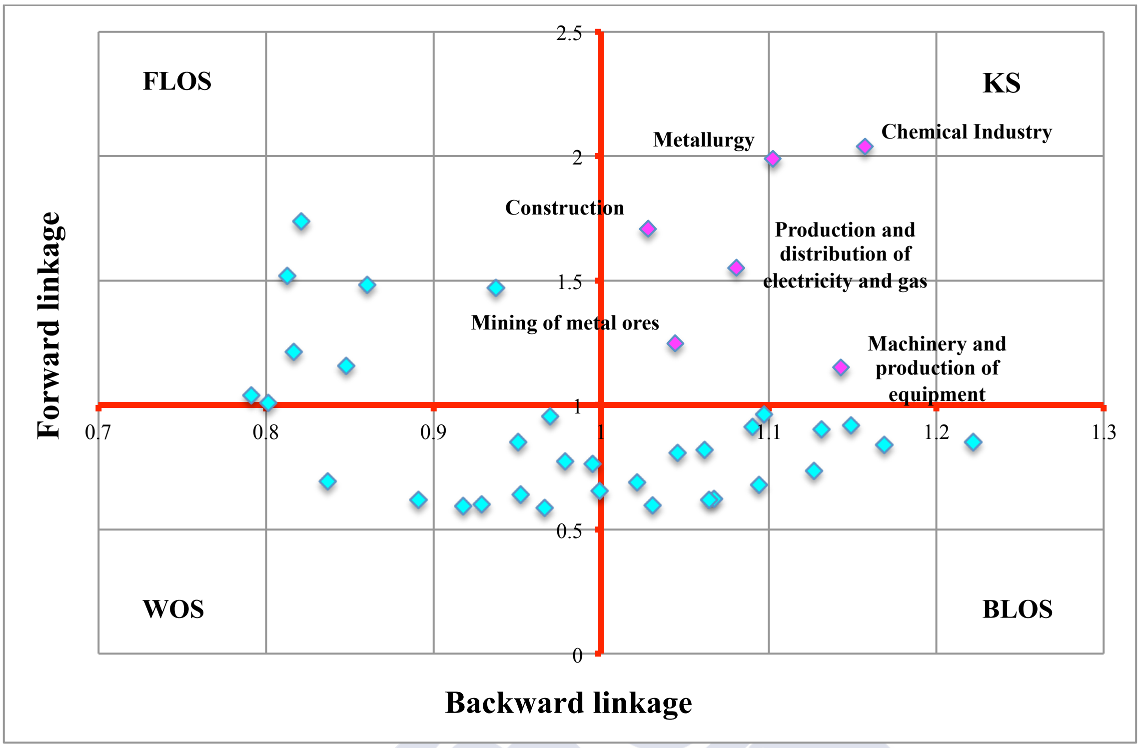
Table 7: Strong Forward Linkages Sectors With Low Coefficient Of Variation

	Sectors	Forward linkage	Coeff. Of variation
1	Mining of metal ores	1.19	4.52
2	Production of wood and cork, except furniture, manufacture of articles of straw and plaiting materials	1.0	5.7
3	Manufacture of other non-metallic mineral products	1.06	5.22
4	Machinery and equipment	1.32	4.51

Source: Own elaboration

As you can see on the *Figure **8***, in red dots are all sectors that have strong forward and backward linkages. In the upper left-hand corner there are forward linkage- oriented sectors (FLOS), which are have strong forward linkages. In the lower left corner there are weak oriented sectors (WOS) which are have weak or less than one both forward and backward linkages. And in the lower right corner sectors that have strong backward linkages (BLOS).

Figure 8: The key sectors of the East Region



Source: Own elaboration

National level

National IOT includes 58 aggregated sectors. The table 8 shows us the key sectors by the Rasmussen's method of cluster identification. As you can see there are only few sectors which have strong both forward and backward linkages. However, sectors with well established forward linkages rather than backward linkages predominate considerably (*Table* ***9***).

Table 8: Key Sectors In The Republic Of Kazakhstan By Rasmussen´s Method

	Key sectors	Backward linkage	Forward linkage
1	Manufacture of coke and petroleum refining goods	1.03	1.34
2	Manufacture of goods of chemical industry	1.09	2.41
3	Manufacture of other non-metallic mineral products	1.14	1.06

Source: Own elaboration

There are only two backward-linkage-oriented sectors, excluding primary and local serving sectors (*Table **10***). Kazakhstan is vast and unevenly populated country. The most of regions are well connected with the capital than with each other. The dispersed localization of industrial complexes is aggravated by poor connection between regions. The country faces a lot of difficulties caused by transportation and infrastructure constraints. In some cases import inputs from neighbour country is less costly than the same inputs from other region of the country in terms of logistics and time-consuming. It leads to the low level of local content in input proportions.

Table 9: Strong Forward Linkages Sector With Low Coefficient Of Variation

	Sectors	**Forward linkage**	**Coeff. Of variation**
1	Production of rude oil and natural gas, providing services in these areas	2.16	2.59
2	Mining of metal ores	1.52	2.71
3	Manufacture of textile goods	1.04	3.63
4	Manufacture of wood and wood products, except furniture; manufacture of goods made of straw and braiding	1.02	3.81
5	Manufacture of paper and paper productions	1.18	3.47
6	Manufacture of rubber and plastic products	1.04	3.28
7	Metallurgy	2.79	2.02
8	Manufacture of fabricated metal products	1.17	2.95
9	Production of machinery and equipment	1.30	2.82

Source: Own elaboration

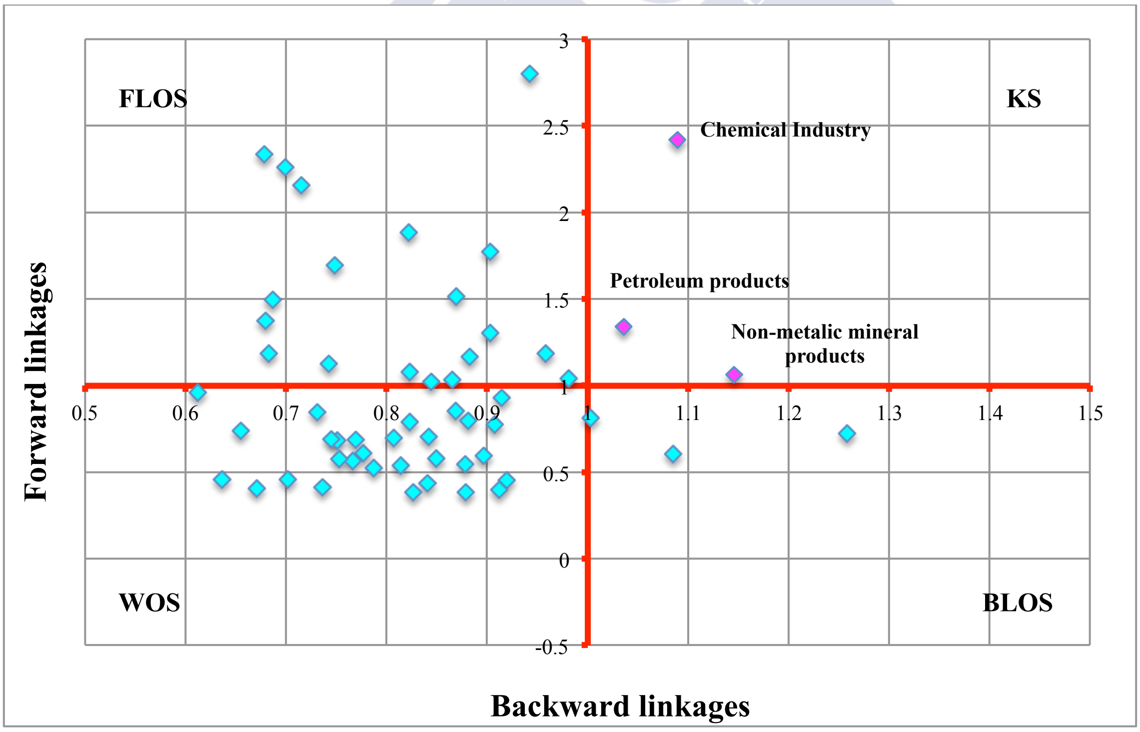
Despite the connectivity problems between industrial complexes, sectors with strong forward linkages are considerably prevailing. We assume that outputs of Kazakhstan´s industries are uncompetitive to sell to international market. Therefore, the most of production are targeted to local market. As well, there is domestic market protection policy in terms of import´s barriers, local-content subsidies and etc. For example, the government increased customs duties on used imported vehicles in order to stimulate growth of domestic car production.

Table 10: Strong Backward Linkages Sector With Low Coefficient Of Variation

	Sectors	Backward linkage	Coeff. Of variation
1	Mining of coal and lignite	9.77	0.43
2	Production of other motor vehicles	1.0	3.97

The upper right corner of the figure represents those sectors with strong backward and forward linkages (*Figure* **9**). Chemical industry, the production of petroleum products and non-metallic mineral products are the sectors with more than average impact on the economy of the country. The most of the sectors have weak backward linkages, which is well seen on the figure. The majority of sectors are located on the left side of picture. Only few of them have a strong interconnection of those sectors from which they purchases inputs.

Figure 9: The key sectors of the Republic Kazakhstan



Source: Own elaboration

1.3. Factor analysis

Factor analysis is method to identify linkages via buyer-supplier relationship based on input-output table. The measures of direct and indirect linkages calculated from input-output table for each sector were treated as variables for factor analysis. The number of factors was defined by the size of eigenvalues and by scree plots. We applied factor analysis to both national and regionalized input-output tables in order to adhere the consistency and interpretability.

Factor analyses were run on the both 58 x 58 national transaction matrix and 39 x 39 regionalized transaction matrix. For each matrix, two matrixes, X and Y were derived (Feser, Sweeney, & Renski, 2005):

$$x_{ij} = \frac{a_{ij}}{a_{+j}}, y_{ij} = \frac{a_{ij}}{a_{i+}}$$

where a_{ij} is the tenge (national currency) value of goods and services sold by industry i in some period to industry j. a_{+j} and a_{i+} are total intermediate good purchases and sales of industries i and j, respectively.

x_{ij} (y_{ij}) captures intermediate good purchases (sales) by sector j from sector i as a proportion of $j's$ ($i's$) total intermediate good purchases (sales). Therefore, the large value of x_{ij} (y_{ij}) means that j (i) industry significantly depends on industry i (j) as a source of its total intermediate purchases (sales).

Four correlations describe the selling and buying patterns of two industries A and B, with the column vector of X matrix and the row vectors of Y matrix.

$r(x_A x_B)$ measures the degree to which industries A and B have similar input purchasing patterns;

$r(y_A y_B)$ measures the degree to which industries A and B have similar output selling patterns;

$r(x_A y_B)$ measures the degree to which the buying pattern of industry A is similar to the selling pattern of industry B;

$r(x_B y_A)$ measures the degree to which the selling pattern of industry A is similar to the buying pattern of industry B.

Based on the largest value of the four correlations for each pair of sectors, linkage L matrix was derived. Performing factor analysis, Kaiser criterion suggests to retain those factors with eigenvalues equal or higher than 1. After running factor analysis we rotate the factor loadings to get a clearer pattern.

Factor analysis of L matrix identified 14 value chains at national level and 8 at regional level, which have eigenvalues greater than 1. For each factor, the analysis generates loadings. In our context, the loading provides a measure of the relative strength of the linkage between a given industry and the derived factors. The higher the absolute value of loading, the more factor contribute to the variable. A negative value indicates an inverse impact on the factor. It is standard procedure, to define loadings greater than 0.5 as significant and worthy of interpretation. Before label each factor we eliminated primary locally-serving sectors from results.

National level

At national level, 14 factors were defined. They explain 87 per cent of the total variance. Based on the content of the variables with high factor loadings, the first factor is labeled as “metalworking”. The eigenvalue of “metalworking” cluster is 13,75 and it explains 23.71 per cent of the total variance. 8 industries with high factor loading were included in this cluster (*Table **11***).

Table 11: Metalworking cluster

	Industry	**Factor loading**
1	Mining of non-ferrous metals	0.5113
2	Other mining and quarrying	0.8629
3	Production of wood and cork, except furniture, manufacture of articles of straw and plaiting materials	0.9404
4	Manufacture of rubber and plastic products	0.8112
5	Other non-metallic mineral products	0.9362
6	Metallurgical industry	0.5741
7	Manufacture of fabricated metal products, except machinery and equipment	0.7603
8	Manufacture of electrical machinery and apparatus	0.6755

Source: Own elaboration

Other well-defined factor is the fourth factor. The majority of industries included in the factor are connected with oil processing. The eigenvalues of "oil processing" cluster is 4.87 and it explains 8 per cent of the total variance. Extraction of crude petroleum and oil-well gas, Manufacture of coke and refined petroleum products and Machinery and equipment were included in the cluster (*Table **12***).

Table 12: Oil processing cluster

	Industry	Factor loading
1	Extraction of crude petroleum and oil-well gas	0.9026
2	Manufacture of coke and refined petroleum products	0.6363
3	Machinery and equipment	0.5829

Source: Own elaboration

Regional level

Based on the content of the variables with high factor loadings, we defined and named factors. We selected only one factor from 8 defined by factor analysis for further examination. Despite the fact that other factors have eigenvalues greater than one, they are not well defined in terms of content of the variables with high factor loadings. "Metalworking" cluster has the highest eigenvalue (13,08) and explains 34 per cent of total variance. It includes following sectors represented in the *Table **13***, with factor loading greater than 0.5.

Table 13: Results Of Factor Analysis

	Industry	**Factor Loading**
1	Other mining and quarrying	0.9357
2	Production of wood and cork, except furniture	0.9432
3	Manufacture of rubber and plastic products	0.8298
4	Other non-metallic mineral products	0.9591
5	Metallurgical industry	0.7210
6	Manufacture of fabricated metal products, except machinery and equipment	0.9339
7	Machinery and equipment	0.7460
8	Manufacture of electrical machinery and apparatus	0.7949

Source: Own elaboration

1.4. Conclusion

In this chapter the implementation of cluster policy promoted by Kazakhstan's government was called into question. Since 2005, the Republic of Kazakhstan has developed seven pilot clusters, including the metallurgical cluster in the East Kazakhstan Region. In order to test the adequateness of the selected clusters, several methods of cluster identification were applied. The study proceeded in two steps. Firstly, backward and forward linkages among industries were measured at both the national and the regional level. In order to be able to work with an input-output table for the region, the national table was regionalized using regional employment data by industry.

The results of the study showed that there is a strongly marked metallurgical specialisation of the region. Metallurgical sectors are strongly interconnected and together have greater than average impact upon the economy of the region. These findings may be useful in order to determine the financial impacts of specific policy changes and their effects on the regional economy.

However, this research also revealed that industrial complexes are very dispersed all over the country and poorly interconnected. The regionalised input-output table shows stronger interdependence among industries than at the national level. There is a negligible number of sectors that use products of other domestic sectors as their inputs.

In practice, input-output analysis is usually supplemented by other methods. Thus, as the second step, factor analysis was used to check the robustness of the results. For the most part, the results were similar with both methodologies.

The study has gone some way towards enhancing our understanding of interconnections among industries in Kazakhstan, and particularly in the East Region. The important finding is that clusters in Kazakhstan are dependent on physical proximity between sectors. The big size of the country, poor infrastructure and remoteness of regions make difficult to form clusters at the country level. Sectors are more interconnected from regional point of view. The results of this research support the idea that clusters spread apart from territorial boundaries.

These results call for deeper analysis that should involve business infrastructure, internal innovation processes and possible market and technological barriers of cluster developments. Examining the government institutions and mechanisms to foster interindustry networking is a valuable next step to more in-depth cluster research.

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Chapter 2. Innovation performance measurement

Abstract

Globalization processes have gradually shifted the basis of industrial competitiveness from static competition to dynamic sustainable improvements. Every country tries to develop and carry out innovation, industrial and regional development policies to increase business competitiveness, taking into account social, economic, cultural and institutional conditions. The purpose of these policies is to reinforce the innovation capability of regions and to enhance regional competiveness and economic growth. In order to know if national and local governments are successful in achieving these policy targets, this chapter is focused on the assessment of innovation performance and business environment of the East Kazakhstan region.

The study was undertaken to design an Innovation Scoreboard for the evaluation of innovation performance in the metallurgical cluster. The scoreboard is composed of a wide range of indicators covering structural conditions, knowledge creation, and innovation at the firm level. The methodology is based on that developed by the European Cluster Observatory, taking into account the specificities of the East Kazakhstan Metallurgical Cluster. The indicators capture external drivers of innovation such as human resources supply and financial support. Firm´s innovation activities are presented by firm investments and collaboration efforts in innovation with research institutions, universities and other related organisations. Innovation outputs and economic effects were included as the last group of indicators. All indicators were discussed in comparison with that of catching-up countries and an average of European countries. The results of the study are then interpreted to offer some policy implications, and to identify areas for improvement in current practices within the cluster.

Introduction

In 2005, the government of Kazakhstan approved the plan to create and develop seven pilot clusters (Kazakhstan, 2005). The Centre for Marketing and Analytical Research of the Republic of Kazakhstan developed the project together with foreign consulting firms JE Austin Associates, and Economic Competitiveness Group. The goal of the project was to increase the competitiveness of sectors not related to the extraction of natural resources. During the first phase of the clusterization, special groups studied fifty five thousand companies, in forty-six industries in twelve regions of the country. Because of resource and financial restrictions, the government determined a limited number of clusters, ostensibly on the basis of their potential for economic development. Seven pilot clusters were selected, including transport and logistics services, tourism, oil and gas machinery, construction materials, food and textile industries, and metallurgy. Some of them were in a more developed stage, while others needed to start from scratch.

Geographical concentration was one of the criteria used in industry selection, as well as the critical mass of existing companies in the industry. The metallurgical complex has a considerable rich recourse base. This complex was formed on the basis of domestic strengths, since Kazakhstan has the largest world's reserves of zinc, tungsten, vanadium, and barite ore, the second largest world's reserves of chrome, phosphate and uranium ores, and the third largest world's reserves of copper, silver, lead and zinc. Kazakhstan ranks also the fourth in world's reserves of molybdenum, the sixth in gold reserves, and the eighth in world's reserves of iron ore. In the underground of the country are estimated to lie 50% of the world's tungsten, 23% of the world's chrome ore, 19% of world's lead, 13% of world's zinc, and 10% of global reserves of copper and iron.[1] The metallurgical sector plays an important role in the economy of Kazakhstan. Its share of the total industrial output is approximately 10%.[2]

Since Kazakhstan was as a resource base for the Soviet Union starting in the Second World War, the region inherited a good system of extracting metallurgical raw materials. Because of this, in the region exists specialized infrastructure and local

[1] According to Цветная металлургия Республики Казахстан, 2007.

[2] According to the Agency of Statistics of the Republic of Kazakhstan, "industry" includes mining, manufacturing and production and distribution of electricity, gas and water. All data presented in this section comes from www.stat.kz.

networking, although equipment and technologies need to be modernized because most of them are extremely out-dated. However, the majority of production is unwrought and semi-manufactured outputs. Because of the lack of specialized facilities, almost all extracted metals and metal products are exported abroad for further processing. Moreover, existing production facilities have a high degree of environmental pollution and technological backwardness.

Production of metals is significantly dispersed over the big territory of Kazakhstan. The metallurgical cluster has been basically initiated in the central region of Kazakhstan,[3] because a significant proportion of metallurgical output is located in that area.[4] However, there are significant metallurgical complexes in the eastern part of Kazakhstan, which are also included in the cluster. Our research is focused only on the Eastern region metallurgical complex. The complexes in Karaganda and in the Eastern region have different specialization and different target markets,[5] which gives us a possibility to consider the Eastern region separately.

In 2011, East Kazakhstan ranks third by the number of research organizations after Astana and Almaty cities. Since 2009, the number has had sustainable rise. The firms accumulate approximately 10% of gross expenditure on R&D (the region reaches the fourth place after the same cities and Mangistau region). The share of East Kazakhstan in the total amount of innovative products of the Republic of Kazakhstan is 14%. The number was strongly affected by financial crisis in 2007, and dropped from 17% to 4.5 in 2008. The level of innovation activity has increased every year and it is considerably higher than the country average.[6] The main parts of the innovative activities are aimed at introducing new technology; equipment and materials, while the majority of innovative products belong to the nuclear sector.

[3] The East Kazakhstan region ranks sixth in regional Gross Domestic Product (GDP).
[4] The metallurgical cluster produced 58,6% of total metallurgical output in the country and 11% of this output belongs to the Eastern region.
[5] Copper, zinc and lead concentrate are the main metallic products produced in the Eastern Region. The share of the region in national production reaches almost 95% for copper-zinc ore, 88% for lead, and approximately 89% for zinc.
[6] According to data of the Customs Control Committee under the Ministry of Finance of the Republic of Kazakhstan.

The paper is structured as follows. Section 2 presents a brief overview of the theories that deal with the relationship between clusters and innovation. Section 3 gives a comparative description of innovation performance in the East Kazakhstan region though the building of a scoreboard on indicators, following the methodology of the European Innovation Scoreboard (EIS). Then Section 4 inquires into the characteristics of innovation processes in the regional metallurgical cluster, and tries to interpret them through a classification of different modes of innovation, using for this effect the results from a questionnaire distributed among metallurgical firms based in the region. Finally, Section 5 offers some concluding remarks.

1.1. Cluster and innovation: The theory

Several theoretical approaches to clusters believe that knowledge and learning are transferred or circulated easier within a cluster. In economic literature, there are two confronting views of cluster origin. According to New Economic Geography, the main reason of cluster convergence is an ability to enjoy cost advantage's position. Krugman (1995) argues that tangible factors such as labour pooling and specialized intermediates are the key factors of cluster convergence. (Krugman P. , Geograthy and Trade, 1991). Opposite approach the Economic Geography and the Regional System of Innovation theory, consider that cluster generate more than just cost advantages. They believe that knowledge and learning are transferred or circulated easier within a cluster. Despite the new technologies and abundant types of connections, the transmission of knowledge is still costly. Therefore the agglomeration is a rational response of firms to easy exchange information, knowledge and expertise (Jaffe, Trajtenberg, & Henderson, 1993). Moreover, the local collective learning is based on the tacit and the local nature of knowledge, which may maintain an important background for the competitive advantage of firm (Porter, 1990).

There are four main theories that describe relationship between innovation and cluster (*Table **14***). Each theory investigates different mechanism or combination of mechanisms through which innovation and knowledge spillover lead to cluster convergence. All bellow-mentioned studies are focused on the advantageous effect of regional proximity. The unit of analysis is a cluster or agglomeration.

For better understanding, it is very important to distinguish "knowledge transfer" and "knowledge spillover". Spillovers are possible at every each interaction and are exchanged beyond the intended boundary. If knowledge flows between the intended people or organisations it calls "knowledge transfer", any knowledge that are exchanged outside the intended boundary is spillover. Moreover, the unintended "use" of such knowledge is considered as "knowledge externalities". People exchange knowledge at three levels. However, the tacit knowledge can be transferred only at individual level (Fallah & Ibrahim, 2004).

Table 14: Main Theories Describing Relationship Between Cluster And Innovation

Theory	Authors	Main Question	Knowledge Spillover	Cost Advantages
Economic Geography	Jaffe (1993), Audretsch and Feldman (1996)	Why is innovative activity concentrated?	This is main reason of cluster convergence especially in innovative sectors.	Not consider
New Industrial Spaces	Porter (1990), Storper and Scott (1989), Saxenian (1994)	Why are cluster's firms more competitive and innovative than dispersed firms?	Knowledge spillover fosters competitiveness and innovations.	Moderately important according to Porter.
Innovative Milieu	Aydalot (1986), Camagni (1992)	Why are cluster's firms more competitive and innovative than dispersed firms?	The learning process plays important role in cluster convergence.	Not important
Regional System of Innovations & Learning Regions		Why are cluster's firms more competitive and innovative than dispersed firms?	The tacitness of knowledge is a main reason of cluster convergence.	Not important

Source: Kesidou (2007)

The considerable attention to knowledge spillover as a factor of cluster concentration was devoted in the Economic Geography (Jaffe, Trajtenberg, & Henderson, 1993). According to Audretsch and Feldman (1996), innovative activities in the same technological field tend to be clustered in space in order to take the advantage of knowledge spillover since innovations are knowledge-dependent. They point out that geographical proximity provides the knowledge inputs that contribute to a technological infrastructure supporting innovative activities. However, in their work there is no evidence how knowledge spillover operates and affects the innovative activity of firm. Other economists such as Baptista and Swann (1998) tested whether firms located in cluster are more likely to innovate than firms outside the cluster. They concluded that geographically concentrated firm benefits most from the exchange of knowledge spillover and therefore grow more rapidly.

The theory is based on the assumption that firms have to belong the same common industry. Knowledge spills over between researchers, entrepreneurs and businesses working in solving similar problem or related problems within one common industry. In literature this type of knowledge spillover is called MAR-spillover by the name of Marshall, Arrow and Romer. It is an intra-industrial phenomenon that allows exploiting economies of scale. Proximity between firms and individuals reduces barriers for knowledge spillover and is considered as a condition for sustained growth. They argued that regionally specialized industries benefit most from transmission of knowledge within same industry.

Porter (1990) pointed out that clustering is mechanism facilitating interchange and flow of information between firms. Cluster lower cost of innovation and divide the risk between partners. Beside cost reductions, clusters provide capacity and flexibility to act quickly. Local suppliers, research institutions, marketing organizations and others partners work closely in a geographical sense, which ensure quicker reactions and a better match with customer requirements. Porter´s concept of spillover is similar to the type of knowledge spillover called MAR (Marshall, Arrow & Romer) in the literature, where knowledge spills over between researchers, entrepreneurs and businesses working in solving similar problem or related problems within one common industry. Like in the case of MAR spillover, Porter argued that knowledge spills over in specialized, geographically concentrated regions and it leads to the economic growth of the region. However, he emphasized the vital role of competition in this process. He believes that fierce competition stimulates firms to innovate.

The New Industrial Spaces theory constituted a major contribution to the theorisation of clustering. Storper and Scott (1989) argued that cluster advantages go far beyond of the agglomerate production system and market transactions. It involves social rules, languages, values, and institutions.

According to another approach, Innovative Milieu, learning process is the main driver of cluster convergence. The non-market relationship among participants facilitates collective learning and reduces uncertainty (Aydalot, 1986).

Regional System of Innovations and the Learning Regions theories emphasise the tacitness of knowledge as the main reason of cluster convergence. Cooperation and complementarities between participants constitute the basis for innovative activity. Research institutions perform as suppliers of knowledge in the form of information and as a provider of human capital to clustered firms. They argued that innovation process could be pursued more effectively if institutions are located close to each other. Proximity allows firms to compare and observe routines and processes of their competitors. As a result, different types of knowledge can be exchanged what increasing the ability to innovate. In other words, face-to-face interactions facilitate the diffusion of tacit knowledge.

There is evidence that proximity affect firms' decision, whether or not to adopt new technologies. Gertler (1995) distinguishes three types of "closeness" in a way of affecting knowledge and innovations. The first one is a geographical or physical distance that mostly affects tangible costs. Organisational distance includes interaction, collaboration, shared workplace practices and training between participating firms. Empirical results show that long and extended interactions between firms are very important for knowledge accumulation (Gertler, 1995). In addition, he pointed out that regulatory systems and institutions that assist firms in maintaining long-term relations with partners are important factors that shorten the organisational distance. Cultural distance that includes common language, modes of communication, customs, conventions, and social norms can create extra costs for innovators as well. According to Lam (1998), the socially embedded nature of knowledge can impede cross-national collaborative work and knowledge sharing.

Beside the internal linkages and collaboration within the cluster, the international linkages serve as a way of "upgrading" knowledge spillover. Bathelt (2004) believes that non-local "pipelines" constitute channels for free entry of new information according market trends and technologies into the cluster. Summie (2003) emphasised that technological knowledge is tacit and circulated at local level while knowledge about market is less tacit and is located in international centres of excellence that firms need to contact. It means that in order to obtain sustainable competitiveness and innovativeness, firms have to establish and maintain external relationships.

The earlier research such as Economic Geography and New Industrial Spaces have been focused on the theorising and qualitative description of case studies. On contrast, the later study identified the quantitative methodology to verify the nature of knowledge spillover. In conclusion, all above mention theories recognise the knowledge spillover as main driving force behind agglomeration of firms in region. These theories are based on the assumption that firms have to belong the common industry. Furthermore, some researchers and scientists recognise the Jacobian spillover. This approach denotes to the effect of the heterogeneity of an agglomeration. The diverse industries are usually not in competition with each other and therefore are more willing to engage in interactions than in case of homogeneous industries. According to the research on Jacobs-spillover (1970), agglomerations with a high degree of diversity ought to, ceteris paribus, enjoy higher income growth rates than regions with more homogeneous firms. Lucas (1988) argued that the cities with variety of complementary industries play the role of external human capital. Positive externalities would occur primarily between different but complementary firms.

Benefits derived by firms from one particular industry are termed localization economies, while benefits obtained from many industries – urbanization economies. Kelly and Hageman (1996) attempted to show that both inter- and intra-industrial spillovers have a positive impact. They exhibited that knowledge spillover within one industry has a positive effect for 11 of 12 industrial sectors under observation. On the other hand, only 2 of 12 sectors have considerable positive effect at intra-industrial spillover. Nevertheless, what type of spillover is dominant depends on industry and firm-level conditions. There is a tendency that firm, which tend to conduct their R&D activities in a more sustainable way are inclined to rely on intra-industrial knowledge spillover. On the contrary, the ground-breaking innovations have a propensity to confide in inter-industrial externalities.

1.2. Application of European Innovation Scoreboard

In order to analyse and be able to compare innovation performance of the East Kazakhstan Region with other regions and countries, we applied the methodology of the EIS. Our goal is to describe the internal innovation performance of the metallurgical cluster in East Kazakhstan.

"*The European Innovation Scoreboard (EIS) is the instrument developed at the initiative of the European Commission, to provide a comparative assessment of the innovation performance across the EU and other leading innovative nations. The assessment is based on a wide range of indicators covering structural conditions, knowledge creation, innovation at the firm level, throughputs and outputs in terms of new products and services*" (Hollanders & van Cruysen, 2008).

The methodology includes 29 indicators, grouped over 7 different innovation dimension and 3 major groups of dimensions (Table 1). The group of "Enablers" captures the main drivers of innovation that are external to the firm and it is divided into two dimensions: "Human resources" and "Finance and support", capturing in total 9 indicators.

"Firm activities" captures innovation efforts that firms undertake recognising the fundamental importance of firms' activities in the innovation process. This group covers 3 dimensions: "Firm investments", covering a range of different investments firms make in order to generate innovations; "Linkages & entrepreneurship", capturing the entrepreneurial efforts and the related collaboration efforts among innovating firms and also the public sector; and "Throughputs", capturing among others the Intellectual Property Rights (IPR) generated as a throughput in the innovation process. This group includes 11 indicators in total.

"Outputs" captures the outputs of firm activities and is divided into 2 dimensions using 9 indicators. "Innovators" captures the success of innovation by the number of firms that have introduced innovations onto the market or within their organisations.

“Economic effects” captures the economic success of innovation in employment, exports and sales due to innovation activities (Hollanders & van Cruysen, 2008).

The EIS 2009 includes innovation indicators for the EU27 Member States as well as for Croatia, Serbia, Turkey, Iceland, Norway and Switzerland (European Innovation Scoreboard (EIS) 2009. Comparative analysis of innovation perfomance., 2010). The countries are divided into four groups regarding to extent of innovation performance based on statistical cluster analysis of Summary Innovation Index over a five-years period.

Those are Innovation leaders, Innovation followers, Moderate innovators and Catching-up countries. Kazakhstan has relatively low level of innovation scoreboard indicators. Therefore, the country is compared with the catching-up group of countries such as Bulgaria, Croatia, Latvia, Romania, Serbia and Turkey.

Some indicators are subject to national context. Therefore, more detailed information about issues regarding the calculation of the indicators is presented in the Table 15.

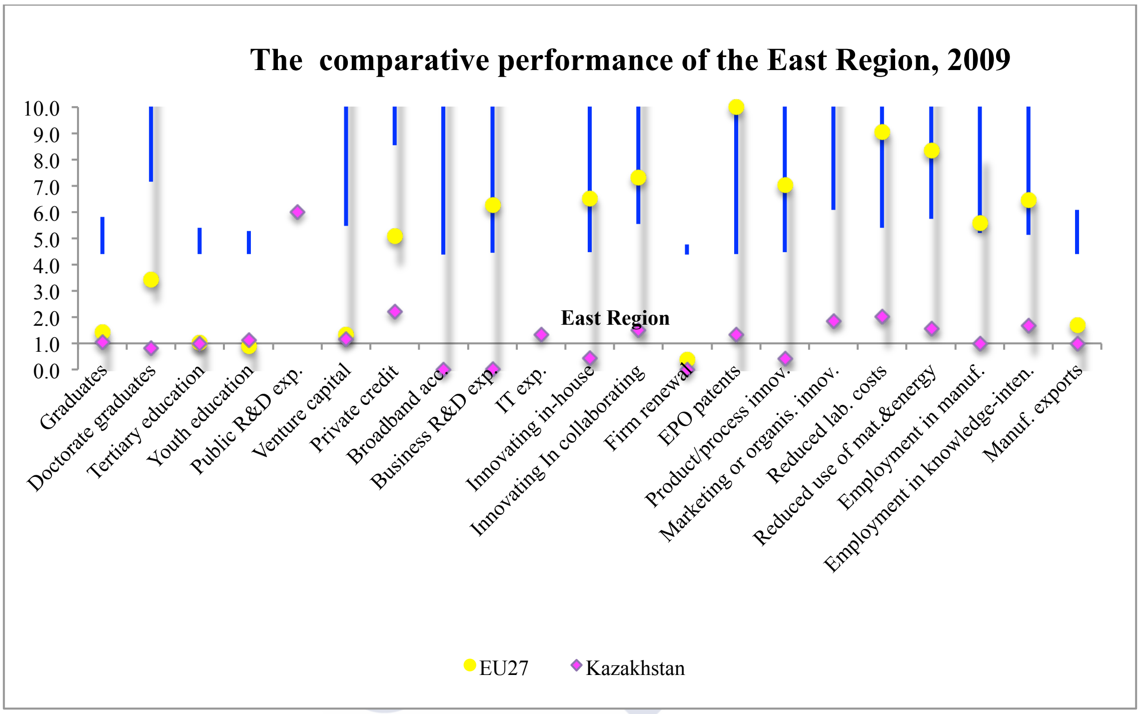
Table 15: Indicators Of Innovation Scoreboard, 2009

	Indicators	*European average*	*East region*
ENABLERS			
	Human resources		
1.1.1	S&E and SSH graduates per 1000 population aged 20-29 (first stage of tertiary education)	40.5	28
1.1.2	S&E and SSH doctorate graduates per 1000 population aged 25-34 (second stage of tertiary education)	1.03	0.3
1.1.3	Population with tertiary education per 100 population aged 25-64	23.5	21
1.1.4	Participation in life-long learning per 100 population aged 25-64	9.5	--
1.1.5	Youth education attainment level	78.1	86
	Finance and support		
1.2.1	Public R&D expenditures (% of GDP)	0.64	0.001
1.2.2	Venture capital (% of GDP)	0.107	0.08
1.2.3	Private credit (relative to GDP)	1.22	0.24
1.2.4	Broadband access by firms (% of firms)	77	5
FIRM ACTIVITIES			
	Firm investments		
2.1.1	Business R&D expenditures (% of GDP)	1.19	0.0013
2.1.2	IT expenditures (% of GDP)	2.7	0.000018
2.1.3	Non-R&D innovation expenditures (% of turnover)	1.03	--
	Linkages and entrepreneurship		
2.2.1	SMEs innovating in-house (% of SMEs)	30	5.9
2.2.2	Innovative SMEs collaborating with others (% of SMEs)	9.5	4.6
2.2.3	Firm renewal (SMEs entries + exits) (% of SMEs)	4.9	12.6
2.2.4	Public-private co-publications per million population	36.1	--
	Throughputs		
2.3.1	EPO patents per million population	114.9	17.17
2.3.2	Community trademarks per million population	124.5	--
2.3.3	Community designs per million population	121.2	--
2.3.4	Technology Balance of Payments flows (% of GDP)	1	--
OUTPUTS			
	Innovators		
3.1.1	Technological (product/service/process) innovators (% of SMEs)	33.7	0.51
3.1.2	Non-technological (marketing/organizational) innovators (% of SMEs)	40	1.55
3.1.3	Resource efficiency innovators (% of firms)		
3.1.3a	Reduced labour costs	18	1.03
3.1.3b	Reduced use of materials and energy	9.6	0
	Economic effects		
3.2.1	Employment in medium-high & high-tech manufacturing (% of workforce)	6.69	3.07
3.2.2	Employment in knowledge-intensive services (% of workforce)	14.53	5.78
3.2.3	Medium and high-tech exports (% of total exports)	48.2	28.4
3.2.4	Knowledge-intensive services exports (% of total services exports)	48.8	--
3.2.5	New-to-market sales (% of turnover)	8.6	--
3.2.6	New-to-firm sales (% of turnover)	6.28	--

Source: Source: Rethinking the European Innovation Scoreboard: A new methodology for 2008-2010

The *Figure **10*** below provides information about the East Region´s performance on each Scoreboard indicator relative to Kazakhstan average (in pink cube), European average (yellow circle) and the indicators´ range of catching –up countries (blue line). It demonstrates all indicators as a fraction of the East Region indicator (X axis). The figure includes only those indicators that are available for the East Region.

Figure 10: The Comparative Performance Of The East Region, 2009



Source: Own elaboration

Enablers

Exogenous factors of innovation performance called "enablers" involve *human resources* and *financial and public support for innovation.* The availability of human resources is crucial to innovation developments. The first two indicators include graduates with training in Science & Engineering and Social Sciences & Humanities. The indicators involve broad educational categories to avoid comparability problems across countries. Moreover, extended number of specialities better capture not only technological innovation but also non-technological innovation.

The science and engineering group are all graduates in life sciences, physical sciences, mathematics and statistics, computing, engineering and engineering trades, manufacturing and processing and architecture and building. Social science and humanities graduates are all graduates in arts, humanities, social and behavioural science, journalism and information, business and administration and law. The first indicator covers only graduates of first-stage of tertiary education and the second indicator is limited by doctorate graduates. Population in corresponding age class is used as a denominator. More detailed information of the comparison of educational levels and the classification of specialities in Europe and the equivalent in Kazakhstan is presented in Appendix.

In the East region, the numbers of S&E and SSH graduates at first-stage of tertiary education is almost the same as European average and similar to the country average. The number of PhD graduates in the region is close to the number for whole country. However, it significantly low relative to the European average. In Kazakhstan, academic and teaching activities are badly underpaid and as a result not popular in Kazakhstan.

Number of first stage tertiary graduates per 1000 population aged 20-29 in East region is similar to the number of the same graduates in Sweden, Slovakia and Italy. On the other hand, indicator of second stage of tertiary graduates is much the same as in Serbia and Latvia.

The general indicator of tertiary education of the region, which it is not limited to particular fields of science, is almost coinciding with European average. However, the number of young people having at least completed upper secondary education is nine per cent higher than European average.

In conclusion, the region as well as the country has relative strengths in human resources compared with catching-up countries. The population possess the minimum qualification level "required for successful participation in a knowledge-based society" (Hollanders & van Cruysen, 2008). The availability of educated people facilitates the adoption of innovation in many areas and positively affects economic growth.

In Kazakhstan, all R&D expenditures in the government sector and the higher education sector region are extremely low. In the East Region, the situation is worse. On the other hand, the indicator of venture capital and the measure of availability private credit are moderately lower than European average and included in "catching-up" range of indicators. Kazakhstan's firms are provided by financial support through private credits and venture capital rather than through public R&D investments.

The amount of venture capital investments of the region is similar to those in Portugal and Denmark and the ratio of credit towards the private sector from deposit-taking financial institutions relative to GDP is analogous to this number in Serbia.

The indicator of broadband access is drastically low in the East Region as well as in whole country. Based on the survey of Department of Statistics of the East Kazakhstan region, only five per cent of firms have broadband access. For example, the number achieves 77 per cent in average among European countries. The lack of broadband access increases the costs to reach national and international market and to absorb new technology, especially it is important for small and medium size firms.

Firm Activities

Beside the exogenous factors of innovation performance, firm activities and efforts contribute significantly to successful adoption and introduction of innovation. Firm activities are measured by firm´s R&D expenditure and by the nature of innovative processes, whether firm innovate in-house or in collaboration with others.

As a denominator of following indicators we use our sample of metallurgical cluster. European indicators are limited to small and medium size firms since almost all large firms innovate in-house and cooperate with others. But in the East Region besides low level of innovation, practically all innovative firms are large firms. Therefore all size firms are included. Although some indicators have to be reduced, since we take only part of expenditure (the expenditure of metallurgical cluster), the reduction is negligible in our case. The majority of total region's investments belong to metallurgical cluster. For example, the share of metallurgical R&D expenditure in total R&D expenditure of the region is 85 per cent. Both indicators of R&D and IT expenditures are radically below of European average and coincide with the minimum of catching-up countries.

To measure networks and linkages between actors, innovative firms are broken down into two groups, those who innovate in-house and firms collaborating with others. Based on our survey of cluster metallurgical firms, only six firms replied that they innovate in-house. Two firms out 388 cluster's firms confirmed that they co-operate with other organizations in innovation creation process. The predominance of in-house innovations is common for the majority of European countries.

Firm renewal indicator is defined as the sum of the number of births and deaths of firms divided by the number of all firms. The importance of this indicator is as a sign of the existence of an innovative environment, facilitating the process known as "creative destruction". The number for the East region is three times higher than European average. This could be misleadingly construed to show that in the region there are favourable conditions for innovation. Actually, the high value of this indicator is triggered by the large number of so-called "one-day" firms. These firms are created to receive quick and easy "money".

Table 16: Illegal VAT Refund

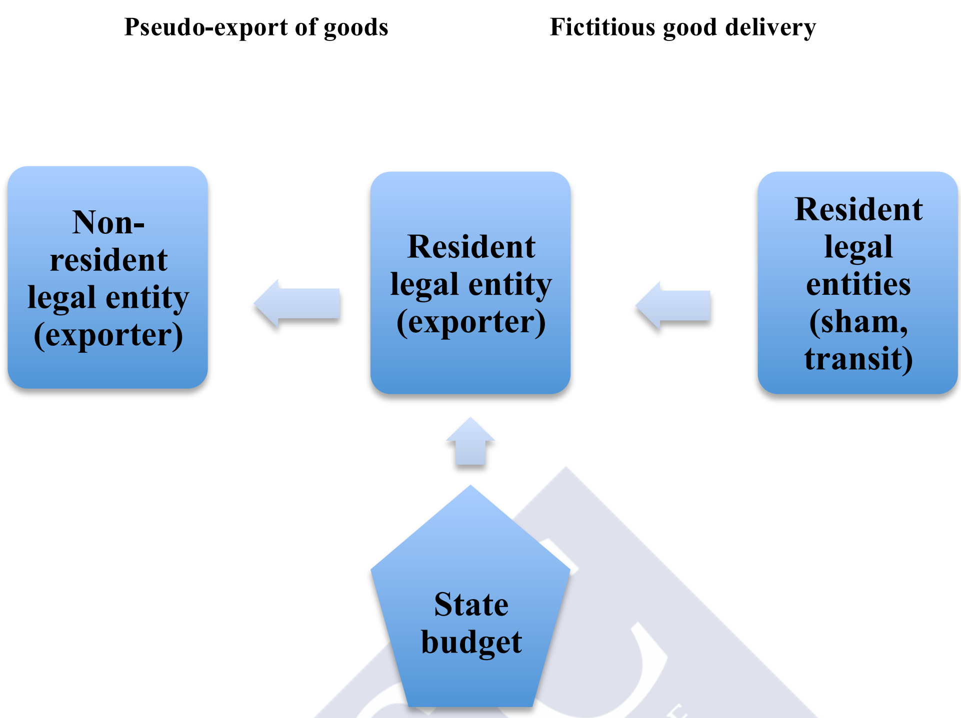
	2007	***2008***	***2009***	***2010***
Tax revenue from VAT (billion KZT)	629.2	640.9	515.9	677.2
VAT refund (billion KZT)	184,7	253.5	266.2	245.1
Number of detected pseudo-firms	n.a.	360 firms	560 firms	725 firms

Source: О.Абдыкаримов (2011)

One of the most popular ways to do it is through illegal VAT refunds. E.g., a firm purchases "virtual" goods and services from "one-day" firms and becomes entitled to a tax credit. "One-day" firms are usually registered in the name of persons who do not exist or who do not have a registered place of residence, and do not meet their own tax liabilities (Pavlotsky & Aleksandr Bryagin , 2009). This scheme is widespread in CIS countries and so called "carousel fraud" (*Figure 11*). The loopholes in legislation difficult the detection of unlawful operations — the right to a tax credit does not depend on whether the input VAT which gives rise to the tax credit was actually paid. Then the allegedly received goods, i.e. without practical realization of the export transaction, are exported to a fictitious or deliberately set-up non-resident company (Risks of Money Laundering in Foreign Trade Transactions, 2010). In Kazakhstan particularly, this scheme has reached alarming sizes in grain export in central regions and in fishing and fish processing in east region (Храмков, 2011).

Tax revenue from VAT is the second largest source of budget revenue, in Kazakhstan. *Table **16*** shows the tendency of growing VAT refund together with the number of detected pseudo firms.

Figure 11: Illegal Tax Refund Scheme



Source: Pavlotsky & Aleksandr Bryagin , (2009)

Another reason for the large number of pseudo firms is participation in tendering or public procurement. One individual or group of individuals creates a pseudo firm and offers the best possible price for supply goods or services in a public bidding. Then, as soon as the firm receives the money, it disappears. Usually, such firms registered to lost documents or dead people. Moreover, corruption of public authority contributes to development of these illegal schemes.

A third reason is relatively small taxation of small business in comparison with large size firms. For example, if it is connected with extraction of natural resources, there is a limit for extraction particular amount of resources per firm, which is defined by the government. The creation of several small firms can significantly increase the allowed amount for extraction.

The number of scientific public-private co-publications measure in which extent knowledge diffusion and research collaboration between public sector and business researchers take place. The maximum of this indicator of catching-up countries is almost third times smaller than European average. “No national statistical data for the publications of researchers in Kazakhstan is available. The information gathered during the visits to HEIs by the OECD team shows that the publication activity of researchers in HEIs varies from 1.5 to three scientific papers per year. It appears also that researchers from the HEIs have traditional access for publishing in Russian specialized scientific journals. Publications in other international journals are, however, quite limited (Reviews of national policies for education. Higher education in Kazakhstan, 2007)".

The number of EPO patents, community trademarks and community design per million population capture intermediate results from the innovation process. The indicator especially important for non-technological and services innovation. Unfortunately, the information of number of patents is available only for the East Kazakhstan and Kazakhstan. According to The Agency of Statistics of the Republic of Kazakhstan, patents´ information is divided by two types: acquired and transferred patents. As a numerator we have used the number of all transferred patents and patents acquired within Kazakhstan. Patents acquired in CIS and other countries are not relevant. Number of patent applied in the East Region is below European average but higher than in catching –up countries.

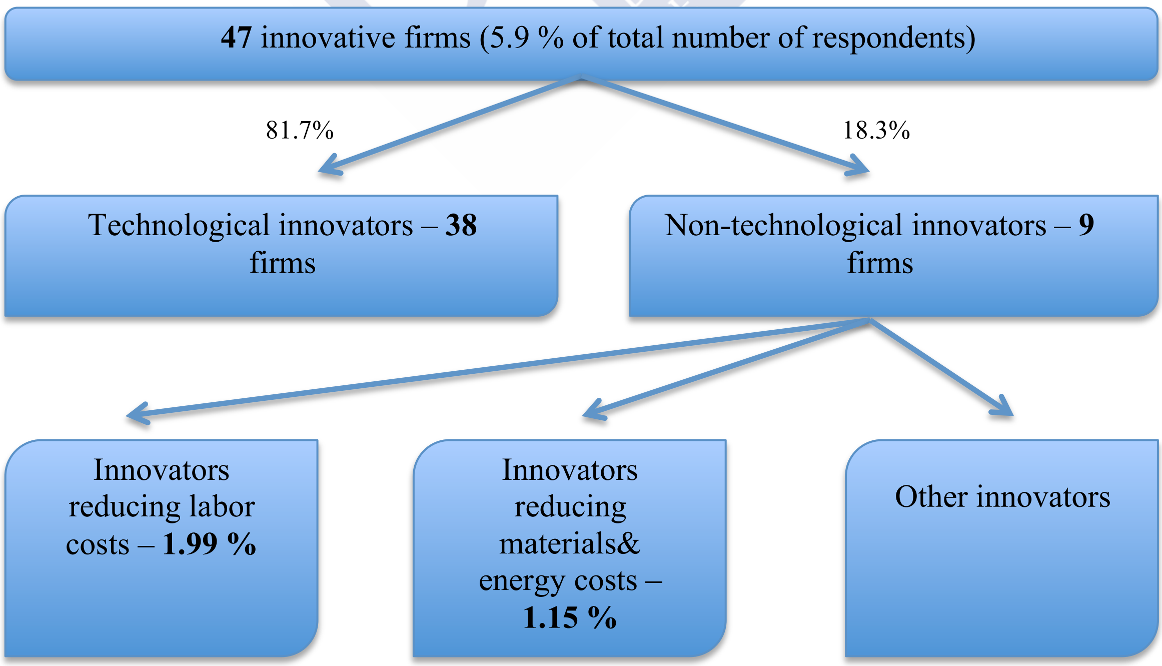
To capture the final results of innovation process three indicators are introduced depend on the nature of innovation. It involves product or process innovations; marketing and organisational innovations; and resource efficiency innovations.

Since the innovativeness of the region is considerably lower than in European countries, it makes cross-regions comparison very difficult. The number of introduced innovations in the region is significantly lower than in catching-up countries as well as among European countries. However, the region introduces more process and product innovations than the country in average. According to the survey of metallurgical firms the most of the innovations in the region are non-technological. According to methodology of The Agency of Statistics of the Republic of Kazakhstan, these innovations are belonging to organizational (non-technological) innovations. This indicator we aggregated based on technological innovation expenditure by types of innovation. The share of product and process innovation expenditures in total innovation expenditure is almost 81 %. Since innovation activity is 5.9 % (5.9% of firms have innovations) we assume that approximately 81% of them technological innovators and other 19% are non-technological innovators.

In order to receive the number of resource efficiency innovations, the indicators are aggregated from the number of firms introduced this innovation. In EIS methodology 2008 innovations reducing labour, materials and energy costs are included in process (technological) innovations category. Reduced labour costs resulting from process innovations

Data is available only in the amount of innovation rather than in number of firms. However, we have total number of innovative firms – 47 firms. We made an assumption that percentage of number of innovations is the same as percentage of number of firms. For example, 12 units of innovation or 10.4% are innovations reducing labour costs out of 115 units of total non-technological innovations and applying the same percentage to number of non-technological firms, we assume that 1.99% firms have innovations reducing labour costs (*Figure **12***).

Figure 12: Aggregation Data Scheme



Source: Own elaboration

As we can see on the *Figure **12***, the majority of innovations are directed in most cases to the reduction of labour costs, not of energy costs.

Economic effect

Economic effect is measured by employment in knowledge-intensive services and medium- and high-tech manufacturing. Services such as telecommunications, financial intermediation and R&D activities provide delivery and diffusion of innovations directly to consumers. *The share of employment in high technology manufacturing* sectors is an indicator of the manufacturing economy that is based on the continual innovation through creative, inventive activity (Hollanders & van Cruysen, 2008). The both indicators are below European average and catching-up range.

Exports of medium and high technology products reflect the ability to commercialize the results of R&D. In the East region, it accounts for approximately 28% of total exports. The number is almost at the bottom of “catching-up” range and twice lower than European average. The *Table 17* shows the list of medium and high technology products, according to European and Kazakhstan´s classification. Products that are exported by Kazakhstan included only.

Innovation performance of the country is well below the European average. Moreover, Kazakhstan is hardly comparable with catching-up countries. Compared with catching-up countries, relative strengths of the country are in Human Resources, availability of private credits, patents application and export of manufacturing goods. However, this educational indicators are purely quantitative and does not give us information about its qualitative characteristics On the other hand, the country is relatively weak in innovation output and finance and support of innovations. All above-mentioned conclusions are true for the East Region as well. However, Business R&D expenditure and the number of product and process innovations of the region are significantly above that of the country average.

Table 17: The List Of Medium And High Technology Products

Code SITC	European classification	Code ТН ВЭД	Kazakhstan's classification
533	Pigments, paints, varnishes and related materials	32	ЭКСТРАКТЫ ДУБИЛЬНЫЕ ИЛИ КРАСИЛЬНЫЕ, ТАННИНЫ И ИХ ПРОИЗВОДНЫЕ, КРАСИТЕЛИ, ПИГМЕНТЫ И ПРОЧИЕ КРАСЯЩИЕ ВЕЩЕСТВА, КРАСКИ И ЛАКИ, ШПАТЛЕВКИ И ПРОЧИЕ МАСТИКИ, ТИПОГРАФСКАЯ КРАСКА, ЧЕРНИЛА, ТУШЬ
57	Plastics in primary forms	39	ПЛАСТМАССЫ И ИЗДЕЛИЯ ИЗ НИХ
593	Explosives and pyrotechnic products	36	ВЗРЫВЧАТЫЕ ВЕЩЕСТВА, ПИРОТЕХНИЧЕСКИЕ ИЗДЕЛИЯ, СПИЧКИ, ПИРОФОРНЫЕ СПЛАВЫ, НЕКОТОРЫЕ ГОРЮЧИЕ ВЕЩЕСТВА
671	Pig-iron, spiegeleisen, sponge iron, iron or steel granules and powders and ferro-alloys	72,73	ИЗДЕЛИЯ ИЗ ЧЕРНЫХ МЕТАЛЛОВ, ЧЕРНЫЕ МЕТАЛЛЫ
71	Power-generating machinery and equipment	84	РЕАКТОРЫ ЯДЕРНЫЕ, КОТЛЫ, ОБОРУДОВАНИЕ И МЕХАНИЧЕСКИЕ УСТРОЙСТВА, ИХ ЧАСТИ
76	Telecommunications and sound-recording and reproducing apparatus and equipment	85	ЭЛЕКТРИЧЕСКИЕ МАШИНЫ И ОБОРУДОВАНИЕ, ИХ ЧАСТИ, ЗВУКОЗАПИСЫВАЮЩАЯ И ЗВУКОВОСПРОИЗВОДЯЩАЯ АППАРАТУРА, АППАРАТУРА ДЛЯ ЗАПИСИ И ВОСПРОИЗВЕДЕНИЯ ТЕЛЕВИЗИОННОГО ИЗОБРАЖЕНИЯ И ЗВУКА, ИХ ЧАСТИ И ПРИНАДЛЕЖНОСТИ
78	Road vehicles (including air-cushion vehicles)	86,87,88,89	ЖЕЛЕЗНОДОРОЖНЫЕ ЛОКОМОТИВЫ ИЛИ МОТОРНЫЕ ВАГОНЫ ТРАМВАЯ, ПОДВИЖНОЙ СОСТАВ И ИХ ЧАСТИ, ПУТЕВОЕ ОБОРУДОВАНИЕ И УСТРОЙСТВА ДЛЯ ЖЕЛЕЗНЫХ ДОРОГ ИЛИ ТРАМВАЙНЫХ ПУТЕЙ И ИХ ЧАСТИ, МЕХАНИЧЕСКОЕ (ВКЛЮЧАЯ ЭЛЕКТРОМЕХАНИЧЕСКОЕ) СИГНАЛЬНОЕ ОБОРУДОВАНИЕ ВСЕХ ВИДОВ СРЕДСТВА НАЗЕМНОГО ТРАНСПОРТА, КРОМЕ ЖЕЛЕЗНОДОРОЖНОГО ИЛИ ТРАМВАЙНОГО ПОДВИЖНОГО СОСТАВА, И ИХ ЧАСТИ И ПРИНАДЛЕЖНОСТИ
88	Photographic apparatus, equipment and supplies and optical goods, n.e.s.; watches and clocks		ИНСТРУМЕНТЫ И АППАРАТЫ ОПТИЧЕСКИЕ, ФОТОГРАФИЧЕСКИЕ, КИНЕМАТОГРАФИЧЕСКИЕ, ИЗМЕРИТЕЛЬНЫЕ, КОНТРОЛЬНЫЕ, ПРЕЦИЗИОННЫЕ, МЕДИЦИНСКИЕ ИЛИ ХИРУРГИЧЕСКИЕ, ИХ ЧАСТИ И ПРИНАДЛЕЖНОСТИ

Source: Own elaboration based on Customs control committee of Ministry of Finance of The Republic of Kazakhstan

1.3. Conclusion

The second chapter has been focused on the assessment of cluster environment in term of innovation performance. This research was undertaken to design the Innovation Scoreboard and evaluate innovation competence of metallurgical cluster in comparison with EU countries. The European Innovation Scoreboard is a tool to determine innovation performance of regions. The indicators capture external drivers of innovation performance such as the availability of human resources and financial support of business sectors. The second group of indicators involves firms´ efforts in innovation processes. It measure to which extent firm invest in R&D and IT technology, as well as collaboration linkages with research institutions, universities and other related organisations.

The study has found that generally the innovation performance of the region is similar to that of the country. The indicator of the country and region are slightly different. The second major finding is that firms´ innovation efforts and innovation outputs indicators are well below the European average. Unsurprisingly, the indicators have shown that the region is placed at the bottom of catching-up countries.

The most surprising evidence to emerge from the study is that the region succeeds in the supply of human resources. This indicator is close to European average. However, the current research was limited to evaluate factors related to qualitative characteristics of the indicator. Moreover, measuring regional innovation performance showed that more progress is needed on the availability and quality of innovation data at regional level.

A future research investigating innovation performance in time period base would be very interesting. It would be useful in order to assess overall progress and improvements in innovation performance. As well, it can change the picture since this study might be affected by the impact of economic crisis on innovation performance.

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Chapter 3. The internal innovation processes

Abstract

The aim of cluster development is the generation of new knowledge and technology through cooperation and active networking between stakeholders. Although the government initiates cluster policies in most cases, private sectors play the most important role in the actual drawing up and carry out of policies. To evaluate the firms´ efforts innovation process, the chapter involves two parts of empirical research.

In the first part, the main drivers of innovation performance are identified based on regression analysis. Literature suggests three factors which affect innovation activities of firms, namely foreign direct investments, R&D investments, and international trade. In order to test this theoretical framework, a probit regression analysis is carried on to estimate the determinants of innovation performance. The chapter makes use of firm level data from the Kazakhstan Enterprise Survey 2009, conducted by The World Bank. The results are supplemented by descriptive analysis.

The second part deals with the examination of multi-level relationships between business organization and innovation. The literature distinguishes between two modes of learning and innovation, based on the distinction between implicit and explicit knowledge. Promotion of R&D and codification of innovation process are main features of the Science, Technology, and Innovation (STI) mode of innovation. On the other hand, the Doing, Using, and Interacting (DUI) mode of innovation is based on learning by doing. In order to discern which innovation model has been adopted by firms in the EKMC, a survey was conducted in the period from November 2011 to January 2012.

Introduction

Innovation performance attracts more and more researchers´ and policymakers´ attention. Today innovation is a key ingredient for rapid and sustainable growth of country. However, if the empirical studies of innovation performance are well discussed in developed countries, there are no many based on developing countries experience. One of the reasons is a low demand for such studies due to a poor quality of statistical data, which makes difficult to rely on (The World Bank. Global Statistical Strategy). Therefore, the research results and conclusion of our study are introduced with some adjustments, taking into account the data imperfections. To fill this research gap was the main motivation of this study.

Industrial innovation processes differ greatly in developed and developing countries. The majority of radical innovations are accounted for developed countries. But it does not mean that industrial innovation is not relevant for less developed countries. LDCs do not make innovations that are original to the world economy, but mastering over products and processes they do innovations original to local economy. Producers assimilate and adapt existing knowledge to domestic circumstances. To do so, the considerable investments in technological capability are important criteria. Beside the differences of two economy contexts, in the both cases it is the creation of entirely new technologies, products, processes, procedures and organisational arrangements.

Unlike developed countries, technological advancement is largely exogenous in developing countries. Still, technical adaptation and assimilation of existing knowledge from more advance economy require technological capabilities from developing countries (Grossman & Helpman, 1993).

Besides the USA, Japan and France, there is limited number of studies for other countries and almost there is no cases based on developing economies. Even existing studies sometime provide contradictory evidences due to dissimilarity of cases, such as different estimated time period, economy and industry specifications and methodological specifications adopted by researchers (Kafouros, 2008).

The paper is structured as follows. The first part analyses the theory behind the determinants of propensity to innovate and discusses some survey-based empirical literature on innovation. The description of the data used and methodology are explained in the second part. Empirical results of regression analysis and conclusion are introduced in the third part.

1.1. Theoretical background

Empirical and theoretical studies highlight three key factors affecting innovation performance: research and development activities, foreign direct investments and international trade.

Knowledge generated by firms´ R&D activities creates an internal stock of scientific knowledge. According many authors, own installed knowledge base increases the absorptive capacity of the firm that enables firms to understand externally generated ideas and technologies, and to apply them to commercial ends (Feinberg & Majumdar, 2001). Therefore, technological capability of firm depends on firm´s investments in R&D and developing human capital (Aw, Roberts, & Winston, 2007).

Firms actively involved in R&D in particular field are more able understand and assimilate the discoveries of others. Based on the example of Norwegian manufacturing plants, firms have higher productivity growth if they invest in R&D (Klette, 1996). Griffith, Redding, and Reenen (2004) illustrate the role of R&D in facilitating the imitation and innovation processes, using a panel data of industries across twelve OECD countries. They found out that R&D is statistically and economically important in catching up processes and improving innovation directly. "…country-industries lagging behind the productivity frontier catch-up particularly fast if they invest heavily in R&D". Interestingly, the study of Griliches (1979) showed that private investments affect firm´s productivity and profitability much higher than federal ones.

There are studies that provide the empirical evidence of positive correlation between exporting and R&D investments. Firms exporting and investing in R&D at the same time about 10 to 17 per cent more efficient than those that only export (Aw, Roberts, & Winston, 2007). Other study confirms that exporters are more willing to invest in new

technology in order to enhance their absorptive capacity (Baldwin & Wulong Gu, Trade Liberalization: Export-market Participation, Productivity Growth and Innovation, 2004). As well, the existence of R&D department in the company increases the probability to introduce innovation. Especially, it is relevant for product innovations (Baldwin & Sabourin, Innovative Activity in Canadian Food Processing Establishments: The Importance of Engineering Practices, 1999).
One of the difficulties associated with the study of innovation is the abundance of research fields it involves. The estimation of R&D´s contribution to a firm´s productivity performance partly shed light on the role of innovation. In terms of econometric specifications they used, all studies are divided by two groups. Both specifications use the Cobb-Douglass production function, where besides capital and labour a measure of R&D capital (the R&D elasticity specification) and R&D expenditure (the rate of return specification) are included. That is, the first specification based on the assumption that R&D elasticity among firms is the same and the second specification assumes the same rate of return to R&D among firms. Evidences elaborated from different specifications are not comparable (Kafouros M. I., 2008).

Measure of R&D elasticity uses either the cross-sectional dimension of the data or time-series dimension data. Usually the first dimension provides higher or negligible elasticity than time-series dimension. The results indicate that in the most cases the R&D contribution to productivity performance is statistically significant and varies from -0.01 to 0.26. The deviation of elasticity depends on the country of study, time period, methodological factors and the definition of output. For example, the use of value added instead of sales can change R&D elasticity from 0.14 to 0.21 (Cuneo & Mairesse, 1984) or from 0.09 to 0.16 (Hall & Mairesse, 1995).

According to the majority of studies, the rate of return to R&D is economically and statistically significant and can be vary from 0.00 to 0.56. As it is with R&D elasticity, results are depending on country and time period selected. Moreover, the use of industry dummies and total factor productivity instead of labor productivity decreases the rate of returns (Kafouros M. I., 2008).

Griliches (1979) estimates the share of R&D in measured productivity growth and it accounts to 0.3 and 0.2 per cent in 1966 and 1970, respectively. The estimation of U.S.

Department of Labour found out that annual contribution of R&D to factor productivity growth in the manufacturing sector is higher and account to 0.49 per cent over the period from 1948 to 1987. Although research activities usually generate spillover effect, the estimations capture only private return to research. Therefore, social return of R&D sizeably exceeds single industry benefits. There is empirical evidence that technological spillover spread across industries boundaries. Thus, U.S. Department of Labour concludes that R&D contributes 0.85 per cent to annual productivity growth during 1948-66.

However, R&D is not only place where innovation is generated. Trial-and-error method is one of examples of information-gathering efforts, which is far outside of research labs. For example, "just-in-time" inventory system was developed on the production side rather than in lab. All information generating efforts and allocation of resources to research contribute to "intentional industrial innovation".

International trade can be expressed in two activities as the selling to export market and the importing of intermediate inputs. Export as a channel of technology spillover, facilitates knowledge diffusion and transfer. Firms learn from information exchange with foreign market, directly or through export intermediaries (Liu & Buck, 2006). Then, communication with buyers and suppliers stimulate firms to improve their own technological capacity and increase quality and specialisation of products. Empirical results from Spanish manufacturing firms confirmed that international trade gives firms the opportunity to benefit from knowledge spillover and learn from exporting and importing (Solomon & Byungchae, 2008). Firms gain from exposure of more intense competition of international market that is force them enhance their innovation activity.

Exporters may have access to valuable knowledge about competing products and customer preferences. The feedback from them allows a firm to advance its market and technological information. Grossman & Helpman (1990) believe that trade facilitate bidirectional exchange of knowledge across boarders. "…local knowledge capital is likely to vary positively with extent of contact between domestic agents and their counterparts in the international research and business communities, and that the number of such contacts increases with the level of commercial exchange (Grossman & Helpman, 1990)."

Study of Rhee, Ross-Larson, & Pursell (1984) shows the existence of technology transfer from foreign buyers on the early development of Korean manufacturing. The majority of interviewed Korean firms agreed that they gain technical information from their foreign buyers through the provision of blueprints and specifications, through information on production techniques and on the technical specifications of competing products and through feedback on the design, quality and technical performance of their products (Rhee, Ross-Larson, & Pursell, 1984).

Other example is describing that Indonesian textile exporter benefit from its Japanese buyer because annually the engineers had been sent to review its production methods and suggest improvements for cost reduction. Finally, it forced him to invest in new machinery (Blalock & Gertler, Learning from Exporting Revisited in a Less Developed Setting, 2004). Two studies demonstrate that learning-by-exporting take place, based on the example of developing countries, Indonesia and sub-Saharan countries. Moreover, poor countries have much more to gain from exposure to international market than developed and middle income countries (Blalock & Gertler (2004) and Biesebroeck (2005). Furthermore, showed evidence that firms in industries with low technological opportunity learn more from exporting than those firms in industries with high technological opportunities (Solomon & Byungchae, 2008).

There are numerous studies that show positive relationship between international trade and productivity. However, only some of them explore the effect of trading on innovation performance. For example, evidence from Belgium confirmed that exporters are more productive and spend on average more on R&D than non-traders (Muuls & Pisu, 2007). On the other hand, some authors assert that export does not increase productivity (Salomon & Shaver (2005) and Vernon (1966)). More producive firms become exporter but there is no causal reverse link. Information flow between local and foreign firms assist to tailor exporting products to the needs of heterogeneous foreign buyers, but it is not enough to enhance firm productivity (Vernon, 1966).

Furthermore, export more likely transfer information about product and customer preferences than about technology process. Then, for instance this information may lead to launch new plant which increase production costs and lower productivity in short-term. Therefore, innovation measures are more appropriate way to assess firm's effort to launch new product or to apply new technological process (Salomon & Shaver, 2005). Salomon & Shaver (2005) found out that product innovation tend to increase approximately two years after exporting. However, it is more time-consuming for patent application. It takes more time from incorporation of technological information to obtain patent. Additionally, J. L. Rodriguez and R. M. Rodriguez (2005) investigated that product innovations and process innovations positively affect the export intensity. In conclusion, export is not only way to increase the scope of firm's market but also a source of information that firm may use to innovate.

Beside the learning-by-exporting, there is evidence that importing is important source of international technology transfer (Blalock & Veloso, Import, productivity growth, and supply chain learning, 2007). Foreign technologies embodied in import inputs directly and indirectly affect innovation performance (Connolly M. , 2003). Indirect effect from importing involves reverse-engineering, which contributes to domestic imitation. However, imitation not only improves firm performance for future imitation but also increase likelihood to successfully invent its own product or make better the equality of existing product. There are examples when firms initially specialized in reverse engineering and "cloning" then, switch to own innovative research (Connolly & Valderrama, 2000). MacGravie (2006) showed in his research a strong linkage between foreign technology and the organizational learning and inventions of importers. Thus, for instance Mansfield and Romeo (1980) argue that reverse engineering is the most frequent channel of technology leak out.

The study of Indonesia shows that reducing input tariffs boosts productivity three times more than a reduction in output tariffs (Amiti & Konings, 2005). Import expands variety and improves input quality (Halpern & Miklós Koren, 2005). Kumar and Aggarwal (2005) emphasized that technology import, in either embodied or disembodied form, is the most important source of knowledge acquisition, especially, in developing countries.

Eventually both exporting and importing facilitate innovation performance by decreasing the cost of implementing technological innovations. If import raises variety and quality of inputs, export increases the market size of the firm that enlarges the future return of R&D investments (Şeker, 2009). Empirical investigation, made by Liu and Buck (2007), reported that learning by exporting and importing promotes innovation in Chinese firms. International treaders access market and technological information, through interaction with foreign agents, that are not available to their local competitors.

Much of empirical literature considers foreign direct investment as important channels of knowledge spillover. Branstetter (2006) showed that FDI increased the flow of knowledge spillover both from and to the firms. Particularly, FDI spillovers are much higher in the relatively high-technology industries than in relatively low-technology industries (Keller & Stephen R. Yeaple, 2003). Despite the fact that FDI bring the employment and capital inflows, it leads to technology transfer for domestic firms. Domestic firms gain from accelerated technological diffusion such labor turnover. Moreover, foreign firms usually spend more on training programs than domestic firms. In the early 1980 countries all over the world have liberalized their policy regarding FDI in order to attract foreign multinational, based on the assumption that FDI positively affect human capital, export, capital formation, technological capacity and productivity of domestic firms. The contribution of FDI to knowledge accumulation by domestic firms, as well as increased productivity and production of host country was well described in many articles (Blomstrom & Kokko, 1998).

MNE´s are considered as main agents of technology transfer since the movements of skilled staff, demonstration effect, and backward linkages facilitate technology adoption of local firms.

Saggi (2000) identified three channels of knowledge spillover through FDI: demonstration effect, labor turnover and vertical linkages. Superior technology of multinational firms may lead host-country firms to imitation and reverse engineering of products and/or practices of multinationals. Labor turnover means that workers employed or trained by multinational firms transfer information and knowledge to host-country firms. Upstream and downstream linkages involve knowledge spillover from multinational firms to its suppliers and customers.

Smeets (2008) believe that knowledge spillover from FDI is most likely to arise is especially important for developing countries. Another confirmation of the importance of FDI for developing countries is that developing economies absorbed an unprecedented US$130 billion more than developed countries in 2012 (UNCTAD, 2012).

S. Feinberg and S. K. Majumdar (2001) demonstrated that FDI generate technology spillover in the Indian pharmaceutical industry. FDI accounted for approximately 14 % of productivity growth in U.S. firms (Keller & Stephen R. Yeaple, 2003). Chinese example confirms positive relationship between FDI and the number of patent applications (Cheung & Lin, 2004).

However, there are opponents in believing that FDI is important source of technology spillover. The impact of FDI is entirely captured by joint ventures and has negative effect on the productivity of domestic firms, using panel data on Venezuelan plants (Aitken & Harrison, 1999). According to Germidis, there is no proof to confirm technology spillover from foreign direct investments. The reasons are that foreign firms are reluctant to share technological information with domestic firms; there is low level of employment domestic employees and the lack of domestic R&D departments (Aitken & Harrison, 1999). The heterogeneity of host-country factors lead to inconclusiveness of empirical research even when similar estimation techniques are used on similar data over similar time period (Lipsey & Sjoholm, 2005).

Apart from the drivers of innovation performance there are externalities that influence on innovation performance of firms. This includes firms' and industry characteristics such as firms' size, age of firms, technological opportunity and foreign presence. Interidustry differences considerably contribute to explanation of cross-industry variation of innovation performance.

The relationship between firm size and innovation performance is the most contradictory topic in innovation literature. Schumpeterian theory argues that large firms can benefit from economies of scale and have both technical and managerial capabilities in order to response immediately to market changes. Usually, big size firms have stable financial position and easier access to finance (Taalikka, 2002). However, more recent studies suggest that positive relationship between firm size and R&D is explained by cost-spreading advantage of large firms. That is, larger firms apply the results of R&D to more products and processes, thus they spread the cost to larger amount of output (Cohen & Klepper, A reprise of size and R&D, 1996). Klepper (1996) argue that cost-spreading advantage can be self-reinforcing over time. The firms´age is strongly correlated with a firm size, since firms is growing over the time. "Older" firm have broader experience and more financial resources to develop and adapt innovations.

It is common practice to examine the difference between technologically advanced and low-tech industries. The most of results show R&D elasticity double higher in high-tech sectors than in low-tech sectors. According to Griliches (1979) the R&D elasticity is changing from 0.03 in the US electrical equipment sector to 0.12 in the chemical industry. The study of Kafouros (2008) distinguishes R&D elasticity of machinery manufacture and electronics industry, 0.06 and 0.15, respectively. Based on empirical results, usually the R&D contribution of metals sectors is smaller than, for example, in electronics sectors (Kafouros M. I., 2008).

Despite the fact that technological opportunity is important in the determining of R&D intensity, it is not clear how to formalize or to measure it. For example, electronics and air travel are at the top regarding technological opportunity and industries like footwear and housing construction are located at the bottom. Technological opportunity of given industry can be described by its advance in scientific understanding as well as technological advances originating outside the industry. All industries of vertical chain of production and other institutions in the economy can enrich technological opportunity within a given industry. Furthermore, there are positive feedbacks from today's research, which generate new starting points for tomorrow. In other words, firms learn from its own R&D. There are also differences in the amount of R&D spending in absolute value or relative to sales (Klevorick, Levin, Nelson, & Winter, 1995). The results of recent studies have showed that firms operating in high technological opportunities industry benefit more due to access to a larger pool of knowledge (Kafouros & Buckley, 2008). To conclude, firms in industries with high technological opportunities are more motivated to sustainable innovation activities.

The most recognizable method to reflect technological opportunity into regression analysis is industry classification represented by Scherer (1965). The classification is based on the closeness of industry to particular science or technological field. Despite the crudely defined dummy variables, the classification has powerful statistical consequences. The variable explains a valuable fraction of variance of patenting activity and R&D intensity (Cohen, Fifty years of empirical studies of innovative activity and performance, 2010). There is number of other classifications based on the distribution of scientific and technological employees (Shrieves, 1978), patents across patent classes (Jaffe A. , 1986), innovation counts (Geroski, 1990) and cost allocation (Levin & Reiss, 1984). Each of these variables was statistically significant in regressions of R&D intensity.

Speaking of technological opportunity, government can contribute considerably in reducing the private cost of innovation, supporting academic research, disseminating technologies, and subsidizing private research. For example, the government has funded biotech sector in US in order to create technological opportunities that were then caught and developed further by new start-ups (Teece, 2010).

As it was discussed above foreign presence through the FDI is positively affect the innovation performance. Firms in industries with low foreign presence rely more on imported goods and their own research in order to increase their technical understanding and improve innovation performance. Additionally, the absorption of technology and know-how from export is more important in low foreign presence sectors (Wang & Kafouros, 2009).

1.2. Data and methodology

In order to test theoretical framework, we employed probit regression analysis to estimate the determinants of innovation performance in Kazakhstan. The paper undertakes firm level data, called Kazakhstan – Enterprise Survey 2009, conducted by The World Bank. The data collected in Kazakhstan during calendar year 2008/2009. The survey covers firms in the manufacturing and services sectors using stratified random sampling was selected. Three levels of stratification such as industry, establishment size, and oblast (region) were used. To obtain unbiased estimates for the whole population, the survey comprises: all manufacturing sectors, construction sector, services sector and transport, storage, and communications sector. Sectors are not included following: financial intermediation, real estate and renting activities, except sub-sector, IT, which was added to the population under study, and all public or utilities-sectors. Finally, industry stratification includes 23 manufacturing industries, 2 services industries -retail and IT-, and one residual. Each sector had a target of 177 interviews (***Table 18***). Regional stratification was defined in five regions: North, West, East, South, and Central. According to size stratification, the number of employees was defined on the basis of reported permanent full-time workers. The data cover the entire population of Kazakhstan´s firms with more than 5 employees. 544 completed interviews are included in the sample (The world bank, 2009).

Table 18: Industry Breakdown

Sector	Frequency	Percentage
Other manufacturing	52	9.56
Food	51	9.38
Textiles	3	0.55
Garments	17	3.12
Chemicals	4	0.74
Plastics and rubber	8	1.47
Non-metallic mineral products	15	2.76
Basic metals	2	0.37
Fabricated metal products	13	2.39
Machinery and equipment	11	2.02
Electronics	8	1.47
Construction section	65	11.95
Other services	9	1.65
Wholesale	63	11.58
Retail	177	32.54
Hotel and restaurants	13	2.39
Transport section	28	5.15
IT	5	0.92
Total	544	100

Source: Own elaboration

The World Bank has produced short report, based on the Enterprise Survey (Kazkhstan country profile 2009, 2009). The main characteristics of business environment in Kazakhstan were highlighted. The following features are important to bear in mind speaking of innovation performance in Kazakhstan.

Kazakhstan has significantly lower indicators of innovative capability of manufacturing sector compare with “upper middle income” countries, East Europe and Central Asia. For example to meet international standards, manufacturing firms invest in attaining industry-recognized levels of production and accounting quality. Thereby, firms with ISO certification or firms have been checked or certified by external auditor are twice less in Kazakhstan than in Eastern Europe and Central Asia. Unsurprisingly, large firms are more likely to have quality certification, to use e-mail and websites in communication with clients and supplies, and to be reviewed by external auditor than small and medium size firms.

Modern communication technologies open doors to innovation and expand market boundaries. Relatively more firms using e-mails to communicate with clients and suppliers than those that have websites for this purpose. However, Internet penetration is still very low. Therefore, some firms are limited to access to reach national and international markets at low costs, especially small and medium size firms. The number of firms adopted foreign technology is slightly less in comparison with Eastern Europe and Central Asia.

Firms operating in open market have an access to better quality inputs at low costs and bigger market size. Additionally, trade is accompanied by international knowledge spillover. Firms exporting abroad are very few in Kazakhstan. Based on the Enterprise Survey 2009, around five percent of firms export in Kazakhstan, less export only Uzbekistan and Azerbaijan. The survey includes the entire manufacturing, the services sectors, and the transportation and construction sectors (Kazkhstan country profile 2009, 2009). Therefore, the country has one of the highest rates of firms with domestic sales solely. Nevertheless, almost 45 percent of firms use inputs of foreign origin and the number reaches 59 percent in the South. But the high rate of import is common in ECA countries. Thereby, Kazakhstan is placed almost in the bottom of import usage rate. The low level of international trade involvement can be explained by high average time needed to clear imports and exports from customs. For instance, it takes 8 and 14 days for export and imports respectively in Kazakhstan and approximately 4 and 8 in ECA countries (Running a business in Kazakhstan, 2011).

Regarding to the main obstacles, Kazakhstan's firms report that corruption is a common and regular way to secure a government contract. Moreover, average value of bribe account to 5 percent of contract value. The indicator is five times higher than in ECA and "upper middle income" countries and increasing to the South of the country. Obviously, large firms are more subjected to bribe giving than small firms.

Expenditures to research and development of both public and private sectors are extremely low in Kazakhstan. In 2009, the number hardly reached 0.23 and it has had decreasing tendency (The World Bank, 2009). Moreover the majority of R&D investments are funded by public sector rather than private sector, that better respond to the market needs. Despite the above mentioned, Kazakhstan climbed from 56 to 49 in 2013 by Doing Business indicators. This testifies that the government has made some institutional improvements. Especially the biggest positive changes the country achieved in the diminishing time of starting business and getting credit (Doing business , 2013).

1.3. Description of variables

Dependent variable

As an output variable we have the declaration of whether an enterprise has introduced new product or services in the last three years (dummy variable) and the sales share of innovative product introduced in last three years (continuous variable). The use of various indicators of innovation allows us discover deferent aspect of the same phenomena and more properly to interpret our results. Firms may differ in terms of ways of innovating and the ways of turning research efforts into sales. Therefore reliance on the introduction of innovation variable alone might give the false impression of innovation processes in Kazakhstan. Innovation output is not easily measurable and moreover takes several years to be realized (Innovation performance of firms in manufacturing industry: Evidence from Belgium, 2007). Assessing both measures of innovation overlaps deficiencies inherent in selecting one measure to the exclusion of the other. Besides the subjectivity of innovation counts (Salomon & Shaver, 2005), it makes possible to gather the information of innovative activities that do not lead to the introduction of actual innovations due to its failure, for instance (Archibugi & Pianta, 1996). On the contrary, the measures of new product sales add a new light to commercialization process and economic benefits of innovation.

In early researches on innovation, patents were used as a measure of innovation output, although technologies are not easily codifiable in from of patents or blueprints. As alternative, Miresse and Mohnen (2002) suggested using innovative sales instead of the number of patents as a measure of innovativeness. Beside the fact that the sales of innovative product cover only product innovations, there are studies demonstrating that the majority of process innovating firms are also product innovators. The introduction of innovation is better measure of innovation performance since it is faster than patenting affected by technological changes. For example, innovations tend to increase maximum 2 years after exporting starts. Patenting has greater lag in time (2005).

Table 19: The Descriptive Of Variables

Variables	Description
Dependent variables	
The introduction of innovation	Dichotomous variable taking 1 if firm introduced an innovation during the last three years
The ratio of new sales product to total sales product	Proportion of total sales represented by new product sales
Independent variables	
Domestic import	Percentage of material inputs and supplies of domestic origin in last fiscal year
Foreign import	Percentage of material inputs and supplies of foreign origin in last fiscal year
Export	Dichotomous variable taking 1 if firm exported in last fiscal year
R&D investments	Dichotomous variable taking 1 if firm invested in R&D in last three years
Control variables	
Foreign presence	Percentage of private foreign individuals, companies or organization in ownership
Size	The number of permanent full-time employees
Technological opportunities	Dichotomous variable taking value 1 if firm belongs to technology intensive sector

Source: Own elaboration

The first dependent variable *y* represents the declaration of whether an enterprise has introduced new product or services in the last three years. By the definition of The Agency of Statistics of the Republic of Kazakhstan, "innovation" is the result of scientific and technological activities, been realized in the form of new or improved products (goods and services) or technology (The Agency of Statistics of the Republic of Kazkhstan). The value takes 1 if the firm introduced new products or services in the last three years and 0 otherwise (*Table **19***).

In the second model the innovation performance is measured by the ratio of new product sales to total sales in a given firm. "New product" is classified as a product or service was introduced in last three years. The ratio of new product sales to new total sales is continuous variable that expressed in national currency, tenge. The new sales product has a number of advantages. Firstly, it better measures the economic value and scope of innovation performance. Secondly, focusing on firm´s efforts to launch new products more directly assesses innovation provoked by international knowledge spillover. It can be indicator of market acceptance and commercialization process. Thirdly, in contrast to patent measure, the ratio consists unpatented product that was employed in the production process i.e. e. "new to firm" (Wang & Kafouros, 2009).

Independent variables

According theoretical framework, there are three factors that determine innovation performance of a firm. To measure international trade we included in the model import and export variables. As an export, the dummy variable is used, where 1 if the firm directly or indirectly exported in last fiscal year, 0 otherwise. Import is divided by domestic and foreign imports. The last one is measured as the percentage of material inputs and supplies of foreign origin in last fiscal year. Domestic import implies import of inputs from domestic manufactures. Dummy variable of R&D expenditure indicates to which extent firm invest in R&D. R&D intensity is determined by whether or not the firm invested in research and development in last three years, including in-house or outsourced investments.

Unfortunately, the Enterprise Survey does not provide information on foreign direct investments. Therefore, the only way to measure foreign involvement is to take into account share of foreign ownership in ownership structure.

Control variables

In order to clarify the effect of explanatory variables, control variables have to be included. The analysis also controls for a number of factors that include firm´s size, foreign presence and technological opportunity.

We strongly believe that size has a great effect on innovation performance. Large firms are able to reap benefits of scale that motivate them to innovate more (Liu & Buck, 2006). Size is one of the widely analysed and recognised determinants of innovation performance. We measured the size of firms as a number of permanent full-time employees.

Wang & Kafouros (2009) proposed to control the state ownership participation. State-owned firms are reluctant to innovate because of the central government´s soft budget constraints and focus on non-economic goals such as expansion of employment. Therefore, firms with high degree state involvement are associated with lower innovation performance. In our case we have a small number of state-owned firms in the sample that indicates good level of liberalization. However, we control foreign presence, expecting strong relationship between foreign participation and innovation performance. Foreign presence we measured by the percentage of private foreign individuals, companies or organization in ownership (Lu & Ng, 2012).

According to Lee and Ging (2004) (Lee & Ging, SME innovation in the Malaysian manufacturing sector, 2007), younger small-sized firms are more likely to innovate compared to older firms, in contrats to medium-sized and large-sized firms, where older firms are more likely to innovate. In our case it is difficult to determine the exact age of firm, whether firm is truly start-up or it is just old firm registered by another name. Especially it is common case, when old soviet firms were renamed and reregistered as new ones after privatisation. Therefore, the age of firm is excluded from regression.

The number of scholars confirms that there is the significant effect of industry classification on innovation performance. For example, A. Jaffe (1986) argued that firms in a given industry patent more in some classes than in others. The sectorial context relates to the fact that belonging to a particular industry may condition a firm's strategy and performance (Rodriguez & Rodriguez, 2005). Therefore, all firms were divided by operating in low-technology industries and high-technology industries, according to Kafouros & Buckley (2008).

Methodology

We apply probit model to measure whether firm introduced innovation or not. Then, regression analysis is carried out for the ratio of new product sales to total sales model. Both models have a reasonable explanatory power. The *Table **20*** represents the mean comparison of innovator and non-innovator firms. As can be seen there is significant difference between two groups of firms. Innovators are intensively importers and exporters than non-innovators. Interestingly, that they import approximately twice higher from abroad that non-innovator. As it was expected, non-innovators export and invest in R&D significantly less than innovators. In our dataset there is distinction between import of domestic origin and import of foreign origin. Domestic inputs are inputs from other regions but within the country and foreign origin inputs are inputs imported from abroad.

Table 20: Descriptive Statistics

Variables	Innovator	Non-innovator	Difference
Domestic import	67,51	83,9	16,39***
Foreign import	32,5	16,1	16,38***
Export[1]	0,073	0,033	0,039**
R&D investments	0,224	0,03	0,193***
Foreign presence	0,09	0,04	0,05**
Size	142,8	87,4	55,4***
Manufacturing and non-manufacturing	0,39	0,29	0,09**

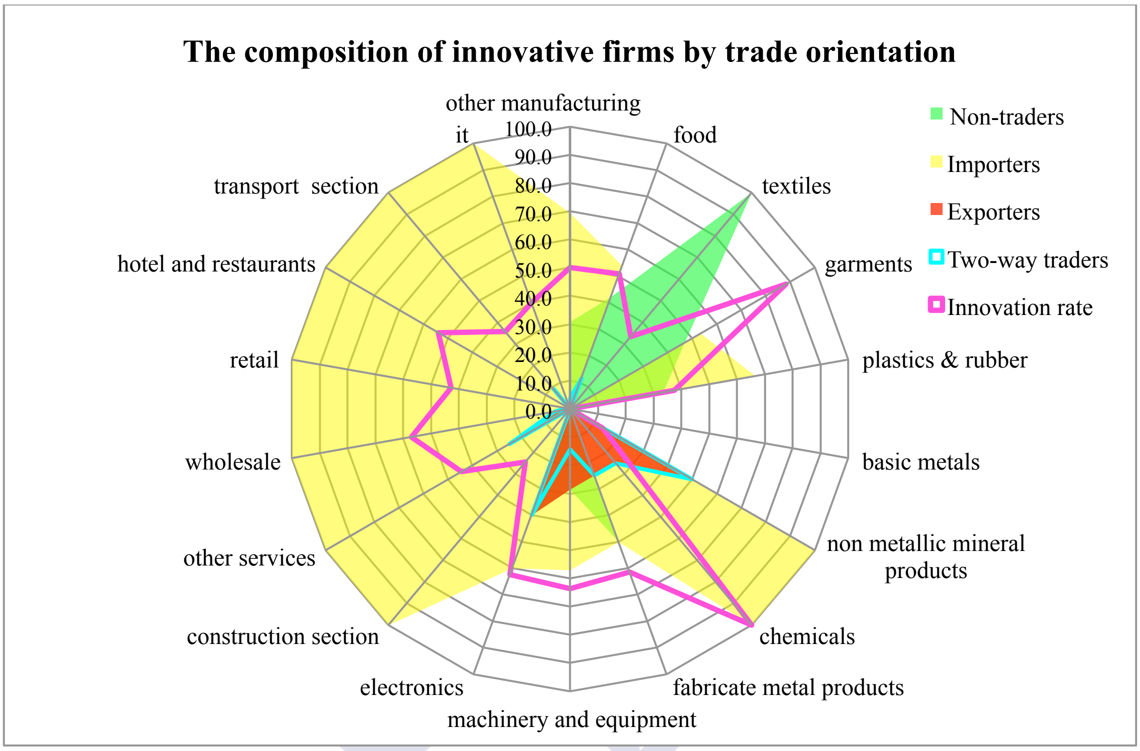
Source: Own elaboration

***Significant at the 0,01 level

**Significant at the 0,05 level

The *Figure **13*** visually shows the composition of innovative firms by trade orientation. Unsurprisingly, the majority of importers are service sectors. However, they have a very low rate of innovation. The highest rate of innovation is well observed in high technology sectors such as chemicals, electronics, machinery and equipment and fabricated metal products. The country exports considerably less than import. Exporters are mostly presented by manufacturing sectors, for instance electronics, machinery and equipment, fabricate metal products, chemical and non-metallic product.

Figure 13: The Composition Of Innovative Firms By Trade Orientation



Source: Own elaboration

Table 21 represents the result of regression analysis of determinants of innovation performance. As can be seen, import of material inputs and supplies of foreign origin have a positive and highly significant impact on the introduction of innovation. However, domestic import has negative and significant effect on innovation performance. Both R&D investments and percentage of foreign import are statistically significant. For a one unit increase in foreign import, the probit index of predictor (introduction of innovation) increases by 0,007. Similar, for one unit increase in R&D investments, the z-score of predictor increases by 1,12.

Although, the coefficients of size, export and foreign ownership are positive, they are not important in the decision to introduce innovation. In contrast to theory, technological opportunity do not have effect on innovation performance. Moreover, the coefficient has a negative sign.

Table 21: Regression´s Results

	First model	Second model
Variable	**Coefficient**	**Coefficient**
Domestic import	-0.0071762**	
Foreign import	0.0071726**	0.0000
Export	0.0434462	-0.0000
R&D investments	1.116533**	0.0000
Foreign presence	0.2866239	0.0000**
Size	0.0012847	0.0000***
Technological opportunity	-0.003	0.0000
Foreign technology		0.0000**
Manufacturing sector		0.0000***
Intercept	-0.3899152*	0.0000***
Number of observations	172	74
Likelihood Ratio	28.99	
Pseudo R^2	0.1220	
Log Likelihood	-104.30523	
R^2		0.7972
Adj R^2		0.7722

Source: Own elaboration

***Significant at the 0,01 level

**Significant at the 0,05 level

*Significant at the 0,1 level

The results of the second model show that the use of foreign technology is positively and highly significant for the proportion of new product sales rather than for the introduction of innovation.

1.4. The modes of innovation

The innovativeness of an organization depends on its prior accumulation of knowledge that makes possible to assimilate and exploit new knowledge. From this point of view, both cognitive and organizational learning play important roles.

Two key models of innovation can be distinguished: the STI model and the DUI model. The first one is the Science, Technology and Innovations (STI) mode that relies on codified scientific knowledge. The other is Doing, Using and Interacting (DUI) mode, based on tacit knowledge and collective knowledge.

All the improvements in machinery, however, have by no means been the inventions of those who had occasion to use the machines" (Smith, 1904). This phrase proves the crucial importance of the STI mode, especially in radical innovations. R&D departments of big firms serve as key players in the STI mode. Usually, any R&D project is evoked by a practical problem. However, the primary search for a solution is based on the STI mode due to the availability of explicit knowledge, such scientific publications or written recommendations. In order to communicate with scientists and scientific institutions it is needed to know their language in codified form. On the other hand, all research results have to be tested, and in this case the results have to be presented in an uncodified tacit form, the language of potential users. Then, *it is not sufficient that the single scientist keeps results in his own memory as tacit knowledge* (Jensen, Johnson, Lorenz, & Lundvall, 2007).

Lundvall and Johnson (1994) suggest using a classification of four different kinds of knowledge for a better understanding of the role of knowledge management. Know-what and know-why usually refer to scientific knowledge (STI) but they also may be achieved through experience and intuition. This knowledge differs across individuals based on their background and training. What to do and why are codified and explicit knowledge that is available through reading books, attending lectures or using databases.

Other two not less important kinds of knowledge are know-who and know-how. They typically develop and improve through every day practice, learning by doing and interacting (DUI). Since this kind of knowledge is highly implicit and tacit it is very difficult to transfer it without human interaction. Nelson (2004), recognizing the crucial importance of the DUI mode for successful innovation said, *much of practice in most fields remains only partially understood, and much of engineering design practice involves solutions of problems that professional engineers have learned "work" without any particularly sophisticated understanding of why*.

Social interactions, context and organizational environment are important for learning and knowledge creation. What makes the DUI mode crucially important as a key source of innovations? It is empirically proved that the successful innovation process involves interaction between people, departments or organizations. Steven Cohn (1980) has observed strong relationships between technical progressiveness and the openness of the formal inter-departmental communication structure. Since human knowledge is mainly tacit and subjective, it is difficult to codify and transfer it. Therefore, the transfer requires good functioning of social interactions, shared understanding and common interpretive schemes (Polanyi, 1966).

By facilitating and supporting the cross-departmental structure and relationships, we enhance and foster learning by using, doing and interacting. For example, problem-solving groups, project teams and task rotation have a positive effect on innovative performance. Moreover, strong linkages to knowledge institutions, including technical support institutions, consultancies or universities are conducive to innovations (Laursen & Foss, 2003).

The DUI model can be described in terms of organizational practice and organizational design. Certain types of organizational design and practice are more likely to yield superior innovative performance in a particular environment. They are more adapted to reduce or avoid transaction costs and cope with market failures.

Organizational practice (the high performance work system) includes *practices designed to increase employee involvement in problem-solving and decision-making such as autonomous teams, problem-solving groups and systems for collecting employee suggestions* (Jensen, Johnson, Lorenz, & Lundvall, 2007). There are two authors who devoted a high degree of attention to this theme.

Walton (1985) believed that a high-commitment model could enhance the organizational performance and lead to more innovativeness. Lawler (1986), calling it high-involvement management, argued that the combined use of particular organizational practices such as team-working, minimal status differences, and job flexibility might have impact on organizational performance. From this perspective, collective knowledge is of utmost importance. Collective knowledge is the accumulated knowledge of the organization, based on its procedures, rules, routines and norms, which comes from the problem-solving activities and interactions among its members

(Walsh & Ungson, G.R., 1991). Collective knowledge depends on the mechanism of knowledge distribution and organizational practice.

Group work provides social and mental space for interpretation of information, interaction and emerging relationship. Shared work experience serves as a foundation for knowledge creation (Nonaka I. , 1994). Social activity and common practice can be used as a bridge between the organization and its members to facilitate knowledge sharing and transfer. Nonaka insists that decentralized, group-based structure is a key principle of a new innovative form of organization (Nonaka & Takeuchi, 1995). Many authors argue that learning and knowledge are embedded in social relationships, shared cognitions and existing ways of doing things.

According to organizational design theories, there are strong links between structural forms and the propensity of an organization to innovate. However, there is no single interpretation of which organizational structure fits better to innovation prosperity. Burns and Stalker (1961) demonstrated how the technological differences and market environment affect organizational structures and innovation management. They distinguished two types of organizational structure, according to environmental differences. One of them, the hierarchical or rigid-type structure is more suitable for stable and predictable environments. On the other hand, when there is rapid change of technologies and market conditions, the flexible structure is more preferable. However, Lowrence and Lorsch (1967) believe that both types of organizational structures can co-exist in different parts of the same organization owing to the different demands of the functional sub-environments. The later work of Mintzberg (1979) argued that bureaucratic structures works well in predictable environments but they are not innovative and cannot deal with environmental changes and novelty.

Lowrence and Lorsch (1967), comparing Japan and the USA, postulated that Japanese firms with a high degree of organizational integration, had a competitive advantage in industries such as electronics and automobiles over the USA because of their ability manage and coordinate specialized divisions of labour and innovative investments strategies.
The literature reviewed above suggests two polar models of learning and innovative organizations, “operating adhocracy” and the “J-form”. The J-form organization is

based on knowledge, which is highly embedded in the operating routines, shared culture and collective relationships. This kind of innovative organization is strongly oriented to an incremental innovation strategy rather than to a radical innovation strategy, and succeeds in relatively mature technological fields. *The organizational community model of learning limits the development of highly specialized scientific expertise, and makes it difficult to adopt radically new skills and knowledge needed for radical learning in emerging new technological fields* (Lam A. , 2004).

The adhocracy is a type of innovative organization where different professional experts with varied skills and knowledge come into adhoc project teams for solving complex and uncertain problems. Career usually develops based on a series of different projects in different organizations rather than within the intra-firm hierarchy. Adhocracy is really an adaptive form of organization, which is able to deal with constantly changing environments and to create new innovations in emerging new industries. It is a type of organization with open boundaries for new ideas, knowledge and staff. However, this fluid structure makes collective knowledge very vulnerable and subjected to knowledge loss (Lam A. , 2004).

One of the most successful examples of adhocracy is Silicon Valley. Despite abundant attempts to repeat this success, adhocracy usually serves as organizational subunits engaged in creative work or knowledge-intensive professional service fields. Large organizations found difficult to adopt and sustain adhocracy in the long-term.

The J-form of organization is more adoptable for coordinated market economies such as Germany or Japan. In this case, their well-developed institutions facilitate long-term business relationships and support continuous but incremental innovations. On the contrary, for liberal market economies like the UK and the USA it is better to apply the adhoc model as they are characterized by high-skilled labour, flexible education systems, and rapidly changing industries or markets.

While measures related to the STI mode, such as the number of R&D expenditures or the number of patents and publications, are well documented, measuring variables related to the DUI mode is very complicated. There are no statistical data available, for example, to measure the hours of cooperation between departments or the number of team-working exercises. However, it has been observed a positive correlation between incentive payment systems, profit–sharing and a high-commitment model (Wood & Menezes, 1998). It this case, financial data can be used as proxy to describe the DUI mode.

Another interesting topic related to innovation processes is the industry-university relationship. Many authors devoted a considerable attention to this topic (Massey, Wield, & Quintas and Karlsen & Isaksen and others). Industries and universities benefit more from each other through close cooperation. Universities have easy access to commercialization of their new ideas in collaboration with industries, while; on the other hand, universities are the main source of fundamental knowledge and innovation for industries.

However, it is harder than it sounds. Isaksen & Karlsen (2010) argue that there is no universal model of industry-university cooperation. This relationship has to be fine-tuned to each individual case. They distinguish four roles that universities play in industry-universities relationships. The roles of universities depend on the innovation mode (DUI or STI) present in regional industrial development. The four roles of universities are following:

- As a source of new industry development.
- As a mediator in acquisition of external investments.
- As an assistance in the technological diversification of existing industries.
- As an assistance in upgrading existing industries.

According to Isaksen & Karlsen (2010), role 1 and part of roles 2 & 3 are relevant for the STI mode of innovation. Universities create entirely new firms by facilitating the spin-off process. These roles support science-driven and entrepreneur innovation processes, since the STI mode is based on scientific and theoretical knowledge. The innovation activity in the STI model mainly takes a place within in-house R&D departments, research institutions and universities. The linear and simple nature of the STI model (Massey, Wield, & Quintas, 1992) makes easier to understand it, and thereby to attract external investments. Industrial development dominated by the STI mode led to the building of research related institutions, incubators facilities, networks and infrastructure. The role of universities in it can be described as the development of high quality research groups, facilitation of the commercialization of research results, and supply of relevant PhD personnel. There is empirical evidence that industry-university cooperation is easily achievable when the STI mode in a particular industry (Karlsen & Isaksen, 2010).

Table 22: Main Features Of STI And DUI Modes

	STI	**DUI**
Main output of innovation activity	New products and processes, usually in form of new patents.	Modification and upgrading of existing products and processes.
Organization of innovation process	Innovation carried out in internal R&D departments. High share of employees with PhD and master education Codification of innovation process	Innovations carried out as part of daily work. Knowledge is mainly tacit therefore poorly documented.
Key external partners	Universities, R&D institutions and research-intensive firms.	Customers and suppliers
Industry-university cooperation	Close cooperation with universities in specific projects and recruitment of PhD candidates.	Universities mainly considered as consultants in solving specific problems, testing solutions.
Role of universities in promoting innovation activity	Commercialization of research results.	Educational role

Source: Karlsen & Isaksen (2010)

As it was mentioned above, in contrast to the STI mode, the DUI mode does not pay a lot of attention to research-based knowledge. It focuses instead on experience and interactions. Employees combining their work experience with their previous education solve problems on the basis of teamwork and trial-and-error exercises. Usually, they rather cooperate with customers and suppliers than with research institutions and universities. Innovations in their majority are just incremental changes in already existing products and processes. Therefore, part of role 3 and role 4 of universities are the most important for the DUI mode, since upgrading and incremental changes are based on experience and customer-driven innovation processes. In this case, universities mainly serve as suppliers of bachelors and masters, which indicate that they are more important as educational institutions than as research facilities. A short description of the main characteristics of DUI and STI innovation modes are showed in *Table **22***.

Table 23: Indicators Of STI And DUI Modes

	Indicators	
1	**DUI-mode** **Interdisciplinary workgroups**	1 if the firm makes some use of interdisciplinary workgroups, 0 otherwise
2	**Quality circles**	1 if the firm makes some use of quality circles, 0 otherwise
3	**System for collecting proposals**	1 if the firm makes some use of system for collecting proposals, 0 otherwise
4	**Autonomous groups**	1 if the firm makes some use of autonomous groups, 0 otherwise
5	**Integrations of functions**	1 if the firm makes some use of integrations of functions, 0 otherwise
6	**Softened demarcations**	1 if demarcation between employee grouping have become more indistinct or invisible, o if they are unchanged or have become more distinct
7	**Cooperation with customers**	1 if the firm has developed closer cooperation with customers to a high extent, 0 if to a small or medium extent or not at all
1	**STI-mode** **Expenditures on R&D as a share of total revenue**	1 if the firm's expenditure on R&D are positive, 0 otherwise
2	**Cooperation with researchers**	1 if the firm cooperates with researchers attached to universities or scientific institutes rarely, occasionally, frequently or always, 0 if it never engages in these forms of cooperation

Source: Jensen, Johnson, Lorenz, & Lundvall (2007)

Nevertheless, we have to bear in mind that these two modes of innovation are theoretical concepts that do not exist in pure form in reality. Usually, industries combine in some proportion both models at the same time.

The choice of methodology for our empirical analysis is based on that applied on the 2001 Danish DISKO Survey (Jensen, Johnson, Lorenz, & Lundvall, 2007).

Methodology suggests using 7 and 2 indicators to measure the DUI-mode and STI-mode, respectively. The first six indicators of DUI model distinguish between rigid and bureaucratic organizations and more flexible and decentralized ones. Cooperation with customers reflects to which extent firms learn by interacting. Expenditure on R&D and cooperation with researchers are the indicators of the STI-mode. Since the evaluation of the DUI-mode is a more complicated and difficult process, more indicators are applied. As it is shown on *Table **23***, variable have been coded for further statistical analysis.

Table 24: Sectors Included In The Metallurgical Cluster

Code	**Sectors**	**Number of firms**
07	Mining of metal ores	43
08	Other mining and quarrying	1
09	Support activities for mining	10
24	Metallurgy	31
25	Manufacture of fabricated metal products, except machinery and equipment	48
28	Manufacture of machinery and equipment not elsewhere classified	5
33	Repair and installation of machinery and equipment	10
43	Specialized construction work (including exploratory drilling and blasting)	19
46	Wholesale trade, except of motor vehicles and motorcycle	3
71	Activities in the field of architecture and engineering activities, technical testing and analysis	204
72	Research and development	45

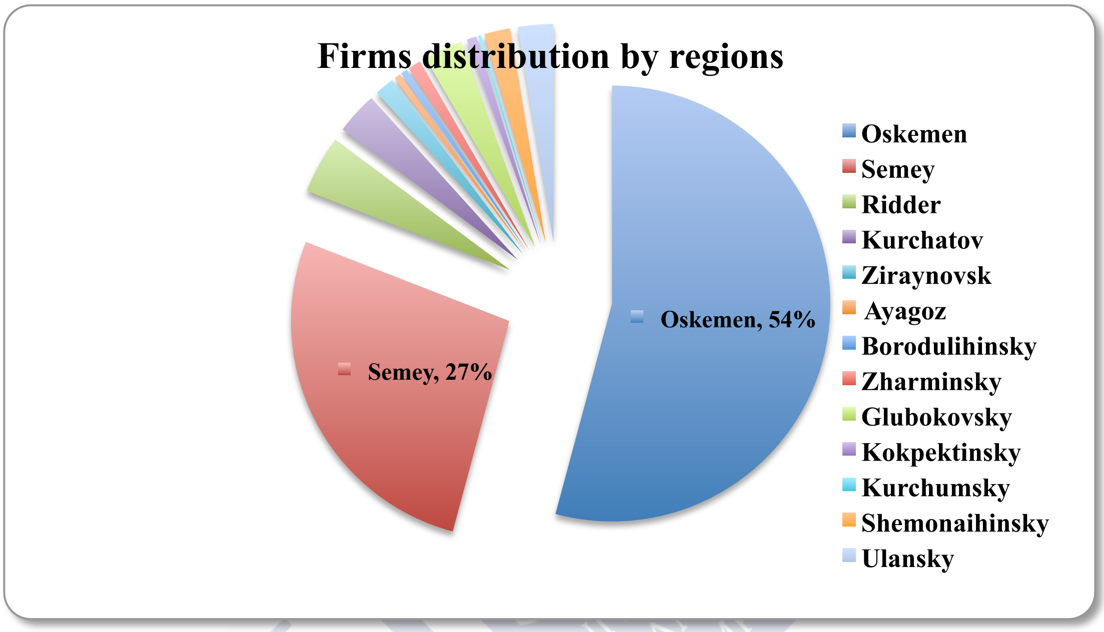
Source: Own elaboration

Our empirical analysis is based on 419 firms in the East Region, including private and government sectors. The majority of the firms (85%) present less than 50 employees. Medium size firms, from 51 to 250 employees, account to 9% of the firm population. Firms with more than 250 employees are the minority (6 %).

We identified firms belonging to 11 sectors related to the metallurgical cluster. As *Table **24*** shows, half of total firms are classified as engaged in architecture and engineering activities, technical testing and analysis.

East Kazakhstan is divided into 4 big cities and 15 administrative districts. The firms belonging to the metallurgical cluster are present in all four big cities and only nine districts. As *Figure **14*** shows, the largest share of firms is concentrated in the cities of Oskemen (54%) and in Semey (27%).

Figure 14: Firms Distribution By Regions

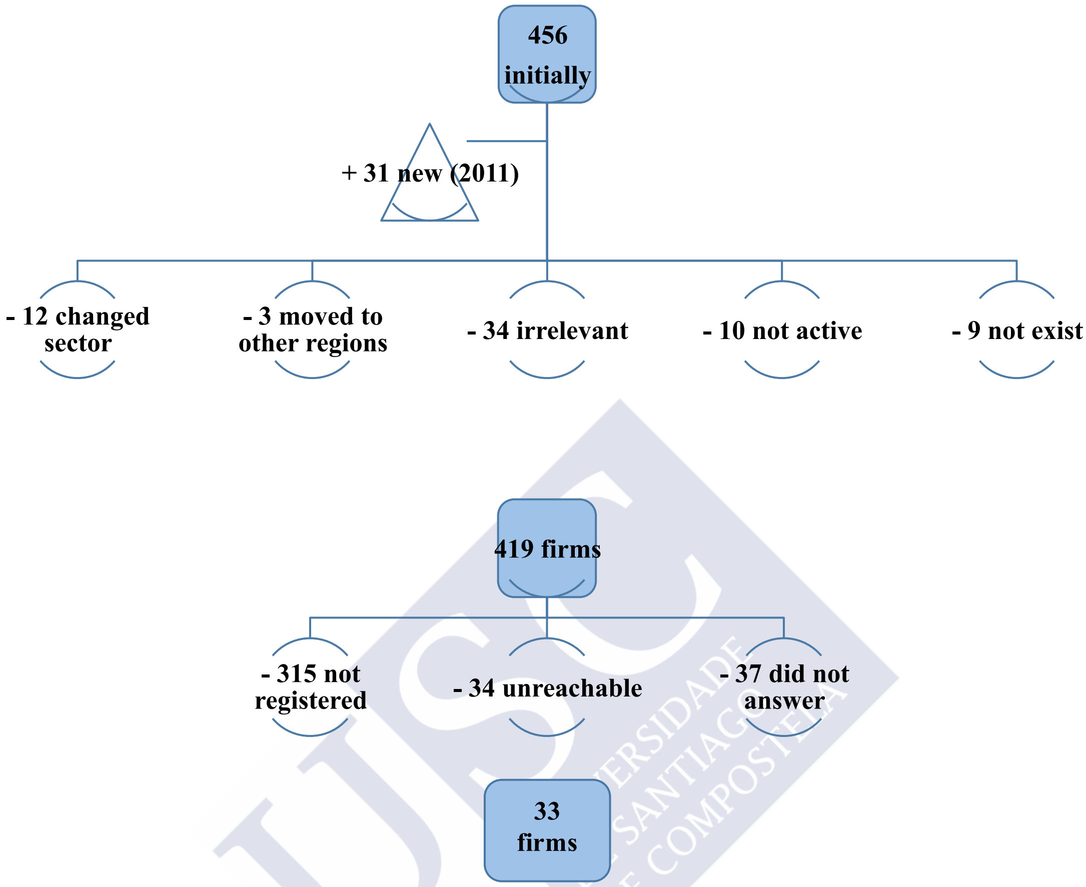


Source: Own elaboration

At the initial stage, we identified 456 firms as belonging to the metallurgical cluster. During the research preparation stage and after interwieving some firms and specialists in this area, the number of firms was reduced to 388 (*Figure **15***). Some firms were deleted due to being irrelevant to our cluster (34 firms). Twelve firms changed the sector where they operate in. Three firms moved into another region and ten are not active any more.[7].

[7] Actual termination of the activity does not mean the liquidation of firm in in the unified state register of legal entities. The firm continues to have completely legal capacity, should pay taxes, take accounting and tax reporting and pay their debts (Закон Республики Казахстан от 17.04.1995 N 2198 "О государственной регистрации юридических лиц и учетной регистрации филиалов и представительств")

Figure 15: The Scheme Of Methodology



Source: Own elaboration

By 2011, nine firms ceased to exist, but 31 firms were created in the sectors identified as part of the metallurgical cluster. Therefore, we increased number of firms to 419 observations by adding 31 new firms.

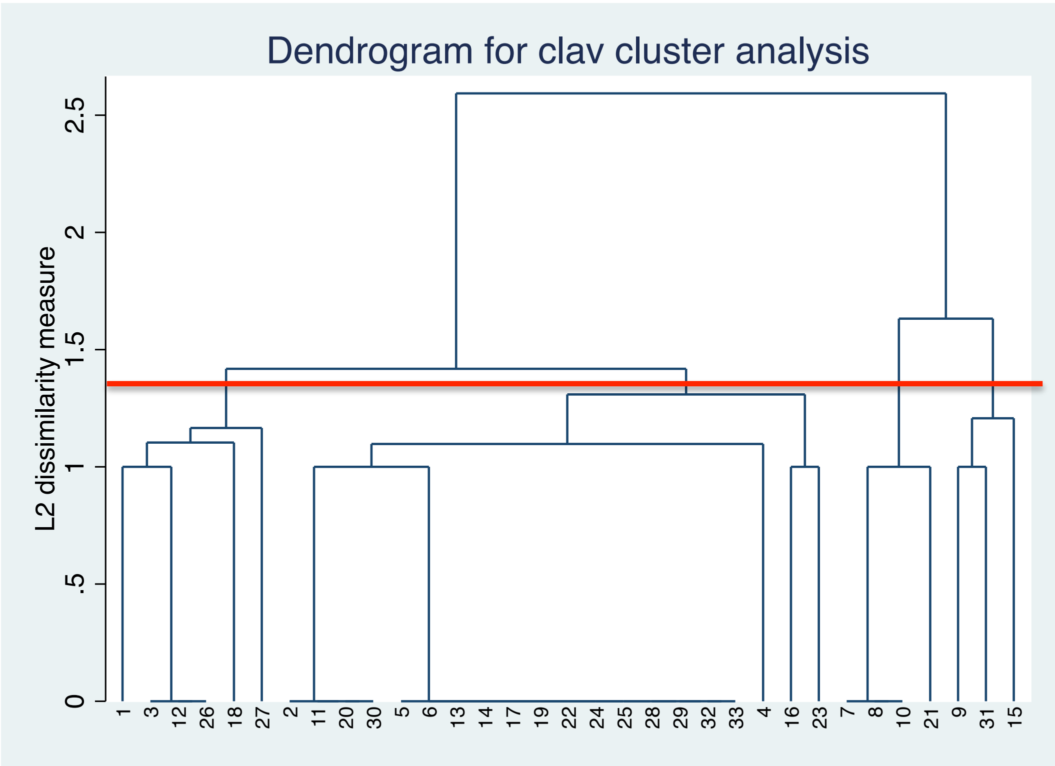
We were able to contact only with 70 firms, to which we sent the questionnaire.[8] Of these, we got an answer from 33 (i.e., a response rate of 48%).

In order to categorize firms into different innovation modes, we have pursued hierarchical cluster analysis. The goal of cluster analysis is to have observations in the

[8] We are investigating further abour the status of the unreachable firms. According to the information we are gathering from indirect sources we get the intutition than most of them (all of a very small size) could be fake, one-day, firms, so we decided to proceed with the other 70.

same group to be more alike than observations in the other groups. The hierarchical method of clustering gradually forms groups going from small to large. The process starts out with each observation considered as its own separate "group". Then, the closest two groups are merged into one group and this procedure continues until all observations belong to one group. The cluster tree in *Figure **16*** allows to visualize the results.[9]

Figure 16: Cluster Tree Diagram



Source: Own elaboration

The most appropriate number of clusters is four. The low learning cluster includes 4 firms. This cluster join together firms that are neither have highly developed forms of DUI or STI modes. The group includes 5 firms that support DUI-learning and spend on R&D and cooperate with researchers, so can be considered as tending to a pure DUI mode of innovation, while three other firms tend to a pure STI mode of innovation.

9 We have used the commonly used cluster average linkage method. We considered also the use of factor analysis. However, factor analysis works on the variables rather than observations. Usually, variables of factor analysis are normally distributed and continuous, where our variables are categorical.

The majority of the firms, 60% of them, combine both modes of innovation. They use a mixed strategy of informal experience-based learning with activities that indicate a strong capacity to absorb and use codified and scientific knowledge.

1.5. Conclusion

Our analysis has produced some important findings. Firstly, high percentage of material inputs and supplies of foreign origin increases probability to introduce innovations. Nevertheless, the firms, importing domestically produced inputs, are less likely to innovate. According to theory, the import of foreign intermediate inputs is more than simply purchasing foreign goods and passively installing it. Whole process includes the development of technological capabilities to introduce new technologies developed abroad, to absorb and use them efficiently, and to adapt them to local conditions. In Kazakhstan, import facilitates the assimilation of skills and knowledge embodied in goods. As a result it enhance local capabilities, since it requires activities required to adopt, adapt, repair and commercialize new inputs. The results confirm that Kazakhstan innovate mostly absorbing new knowledge and technologies embodied in import. Import may involve the purchases of foreign intermediate inputs as well as the import of machinery and equipment. Therefore, reverse engineering and learning-by-doing may take place.

There are examples when some nations turning early technology imports into a domestic capacity for the sustained production of locally adapted innovations. For example, some empirical studies showed that reducing tariffs on intermediate inputs raise productivity via learning, variety and quality effects (Amiti & Konings, 2005).

The second evidence is the acquisition of foreign technology and the presence of foreign ownership increase the ratio of new product sales. The explanation can be that the acquisition of foreign technologies is accompanied by the absorption of new knowledge and skills. The introduction of new product always requires some experience and practice in launching new production. Usually, purely or partly foreign ownership is associated with new knowledge and experience embodied in personnel. This significantly contributes to the introduction and commercialization of “new to firm” products. Example of Chine, shows that firm that are exposed to foreign acquisition

have considerable increase in new product development and R&D upgrading (Girma, Gong , Görg , & Lancheros , 2012). Foreign ownership as well as foreign technology are accompanied with knowledge transfer that offer valuable opportunities for absorption and adaptation new knowledge.
However, foreign technologies and foreign presence are critical only to firms´ capability to launch new product rather than to introduce innovation. This statement leads us to conclude that the firms with the high ratio of new product sales are more likely to imitate new technology or product and commercialize them at local market.

The export is not statistically significant but in high-technology sectors such as chemical, electronics, machinery and equipment and fabricated metal products there is high propensity to innovate if firm is exporter.

The relationship of industry characteristics and likelihood to innovate appear to be complex. The extent of technological opportunity, foreign ownership and firm size are not important determinants of innovation. However, bigger number of employees is associated with higher probability to sell new products. Unsurprisingly, manufacturing sector innovate more than non-manufacturing because they are more involved in international trade. Innovation performance of service sector and construction heavily depends on importing, which is consistent with theory.

We can argue that international trade, and particularly import is crucial for firms´ innovative capabilities. However, foreign presence in terms of foreign ownership and foreign technologies are critical for new product sales. In other words, innovative firms are more likely to derive external information and assimilate it through international trade, rather than from foreign presence.

This study contributes to the innovation literature by examining the factors of innovation performance based on the example of Kazakhstan. The analysis delivered a number of findings that may update the academic and managerial understandings of innovation policy.

Our finding that firms in the low learning cluster are all firms with less than 50 employees supports the “Schumpeterian hypothesis” of the relative innovative advantage of large firms where markets are characterized by imperfect competition (Schumpeter, 1950). Since the innovation activity is positively correlated with R&D expenditures, large firms invest and innovate intensively than small and medium size firms. The evidence from our analysis confirms that business R&D expenditure (88%) are predominating over the public R&D expenditure.

Our findings are particularly important and relevant for metallurgical cluster. Mining and metallurgical sectors usually requires the large amounts of capital investments for long period of time under conditions of substantial technological, geological and market risk. Therefore, only large firm is able to take large up-front investments with long time of payback possibilities.

Almost all firms in the low learning cluster belong to the Casting of other non-ferrous metals sector (code 24540). This can be explained by the technological nature of the sector, which is not technological intensive sector.

The majority of firms with employment higher than 250 employees adopted organizational practice designed to promote scientific and codified knowledge exchange, problem-solving and learning among their employees (DUI/STI modes). The small number of respondents does not give us opportunity to apply regression analysis in order to analyse the effect of learning modes on firm innovative performance, which might be an important topic for future research.

Our research raised a number of problems caused by the lack of data and/or the interpretation of the data. For example, there are a large number of pseudo firms that seriously hampers the usefulness of the statistical information available. The high number of firms that do not actually exist may lead to an overestimation of the economic effect of the metallurgical cluster. Because of all this, it is difficult to achieve a meaningful description of the economic processes occurring in the East Region, so we want to conclude this paper with a note of caution regarding statistical data in Kazakhstan. They should be treated with care, taking into account the particularities involved in gathering data about transition economies.

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Conclusion

a) Main findings by chapters

The second chapter called into question the implementation of cluster policy promoted by Kazakhstan's government. In order to test the adequateness of the selected clusters, several methods of cluster identification were applied. The study proceeded in two steps. Firstly, backward and forward linkages among industries were measured at both the national and the regional level. In order to be able to work with an input-output table for the region, the national table was regionalized using regional employment data by industry.

The results of the study showed that there is a strongly marked metallurgical specialisation of the region. Metallurgical sectors are strongly interconnected and together have greater than average impact upon the economy of the region. These findings may be useful in order to determine the financial impacts of specific policy changes and their effects on the regional economy.

However, this research also revealed that industrial complexes are very dispersed all over the country and poorly interconnected. The regionalised input-output table shows stronger interdependence among industries than at the national level. There is a negligible number of sectors that use products of other domestic sectors as their inputs.

The study has gone some way towards enhancing our understanding of interconnections among industries in Kazakhstan, and particularly in the East Region. The important finding is that clusters in Kazakhstan are dependent on physical proximity between sectors. The big size of the country, poor infrastructure and remoteness of regions make difficult to form clusters at the country level. Sectors are more interconnected from regional point of view. The results of this research support the idea that clusters spread apart from territorial boundaries.

The third chapter has been focused on the assessment of cluster environment in term of innovation performance. This research was undertaken to design the Innovation Scoreboard and evaluate innovation competence of metallurgical cluster in comparison with EU countries. The European Innovation Scoreboard is a tool to determine innovation performance of regions. The indicators capture external drivers of innovation performance such as the availability of human resources and financial support of business sectors. The second group of indicators involves firms´ efforts in innovation processes. It measure to which extent firm invest in R&D and IT technology, as well as collaboration linkages with research institutions, universities and other related organisations.

The study has found that generally the innovation performance of the region is similar to that of the country. The indicator of the country and region are slightly different. The second major finding is that firms´ innovation efforts and innovation outputs indicators are well below the European average. Unsurprisingly, the indicators have shown that the region is placed at the bottom of catching-up countries.

The most surprising evidence to emerge from the study is that the region succeeds in the supply of human resources. This indicator is close to European average. However, the current research was limited to evaluate factors related to qualitative characteristics of the indicator. Moreover, measuring regional innovation performance showed that more progress is needed on the availability and quality of innovation data at regional level.

The fourth paper has investigated the drivers of innovation and internal innovation processes in the region. Multiple regression analysis revealed that import and R&D investments are conducive to innovation processes in Kazakhstan. The present study confirms previous findings and contributes additional evidence that R&D and international trade are main drivers of innovation performance. However, the investigation makes several noteworthy contributions that developing countries benefit more from importing than exporting in terms of innovation introduction. The second major finding was that foreign presence is critical to firms´ capability to launch new product rather than to introduce innovation. However, with a small sample size, caution must be applied, as the findings might not be fully transferable to other economies. The research proposes that there is a considerable causal relationship between internationalisation and innovation. This finding can be useful for policy-makers which is require take into account the alignment between policies aimed at the supporting innovation and those aimed at supporting firms´ international activities.

In order to investigate internal innovation process, we have pursued hierarchical cluster analysis. The empirical results support theoretical predictions that large firms have relative innovative advantages, where markets are characterized by imperfect competition. Our findings are particularly relevant for metallurgical cluster, since this sector usually requires the large amounts of capital investments for long period of time under conditions of substantial technological, geological and market risk. Therefore, large firm is able to take large up-front investments with long time of payback possibilities. The sample size made unable to apply regression analysis in order to analyse the effect of learning modes on firm innovative performance, which might be an important topic for future research. Finally, the number of important limitations needs to be considered. Firstly, the research raised a number of problems caused by the reliability of data and/or the interpretation of the data. Secondly, results should be treated with care, taking into account the particularities involved in gathering data in transition economies.

b) General conclusion

The dissertation has investigated the development of the metallurgical cluster in the East Region of Kazakhstan. The findings of the study indicate that the EKMC can be recognized as an agglomeration of companies clustered due to their physical proximity. Taken together, the results have shown a big lack of participation and support of central and local governments, even though cluster policies were initiated by the government. Eventually, the cluster has not become a contributing factor of regional innovation capability.

c) Future research and possible extensions

The research has thrown up many questions in need of further investigation. The following areas might be undertaken for future study: the effects of clusters on local communities, such as the specialisation of labour force and job creation, using time series data; the contribution of the cluster in promoting a balanced national economy, using multiregional input-output tables. More research is needed also to be able to measure the potential development of the cluster beyond regional boundaries.

LIST OF FIGURES

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APPENDIX I. -European Classification Of Specialities And Corresponding Classifications In Kazakhstan

Code	European classification	Code	Kazakhstan's classification	
			Broad group	**Field of study**
ISC42	Life science	050600	Естественные науки	
ISC44	Physical science	050600	Естественные науки	
ISC46	Mathematics and statistics	050601	Естественные науки	Математика
ISC48	Computing	050602	Естественные науки	Информатика
ISC52	Engineering and engineering trades	050712 and 050716	Технические науки и технологии	Машиностроение и Приборостроение
ISC54	Manufacturing and processing	050728	Технические науки и технологии	Технология перерабатывающих производств
ISC58	Architecture and building	050420 and 050729	Искусство	Архитектура и Строительство
ISC21	Arts	050400	Искусство	
ISC22	Humanities	050200	Гуманитарные науки	
ISC31	Social and behavioral science	050501	Социальные науки и бизнес	Социология
ISC32	Journalism and information	050504	Социальные науки и бизнес	Журналистика
ISC34	Business and administration	050510	Социальные науки и бизнес	Государственное и местное управление
ISC38	Law	050300	Право	

Source: Own elaboration based on United Nations Educational, Scientific and Cultural Organisation

APPENDIX II. Level Of Education In Kazakhstan And Europe

Levels of Education Under ISCED-97	Equivalent in the Kazakhstan education system
IISCED 0 - PRE-SCHOOL EDUCATION. The first stage of organized instruction, mainly intended to prepare small children for schooling	Pre-school education
ISCED 1 - PRIMARY EDUCATION. Usually intended to provide schoolchildren with basic knowledge in reading, writing and mathematics.	Primary education
ISCED 2 - LOWER LEVEL OF SECONDARY EDUCATION. On the whole, the lower level of secondary education continues basic programs of the primary level, although there is more instruction in individual disciplines, often requiring a more specialized teaching staff.	General secondary education (9 years)
ISCED 3 - THE SENIOR LEVEL OF SECONDARY EDUCATION. The final stage of secondary education in most OECD countries. Instruction is more focused on individual subjects than at ISCED 2 and, as a rule, teachers have a higher level of training or qualification in individual subjects.	
ISCED 3A - Programs are intended to prepare for subsequent instruction under ISCED 5A programs.	Complete secondary education (11 years), whether completed in general secondary schools or other establishments.
ISCED 3B - Programs to prepare for subsequent instruction under ISCED 5B programs.	Lower professional education following general (9 year), secondary school, giving a diploma of complete (11 year) secondary education. Medium professional education (medium special educational institutions) following (9 year) general secondary school.
ISCED 3C - Programs not intended for a direct transition to ISCED 5A or 5B programs, but for direct access to the labour market, or instruction based on ISCED 4 or other ISCED 3 programs.	Lower professional education following a complete secondary school course.
ISCED 5 - THE FIRST STAGE OF TERTIARY (HIGHER) EDUCATION. In terms of content, programs of this level are more advanced than ISCED 3 and 4.	
ISCED 5B - Programs are, on the whole,	Medium professional education, following

more practical (technical) and professionally oriented than ISCED 5A programs.	complete (11 year) secondary school.
ISCED 5A - Programs are largely of a theoretical character, training learners for subsequent transition to ISCED 6 programs or for jobs, which require significant professional skills.	Higher professional education (programs for bachelors and specialists, Master's program)
ISCED 6 - THE SECOND STAGE OF TERTIARY EDUCATION. Tertiary education programs, which lead to obtaining an academic degree of Master or Doctor. They involve in-depth study of selected disciplines and independent research.	Candidate of science, Doctoral program.

Source: Own elaboration based on United Nations Educational, Scientific and Cultural Organisation